POWER

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His Excellency Calvin Coolidge, Governor of the Commonwealth of Massachusetts said at the recent Engineers' dinner at Boston:

The Engineers are the Ministers to Civilization

HERBERT HOOVER, ENGINEER

Roscoe Pound, Dean of Harvard Law School, said upon the same occasion:

After all, Civilization is nothing but a continually more perfect social engineering

Can you conceive of a system in which every natural resource is used to the best advantage; in which natural and manufactured products are prepared for use and distributed to the consumer by the most efficient machinery and methods and with the least possible loss and waste; by men who, from the highest executive to the least responsible laborer, are especially fitted for the parts they are to play, all imbued with the idea of Service and a full appreciation of the fact that the better and more efficiently they serve, the more product and the fuller, better life there will be for each and for all?

Would there not be PRODUCTION, ABUNDANCE, CONTENTMENT, PROGRESS?

This would be CIVILIZATION; a more perfect SOCIAL ENGINEERING, an orderly application of the forces and resources of nature to the benefit and use of man.

The man to bring it about is the "Minister to Civilization"— THE ENGINEER.

Among those whose names are familiar to the readers of history, whose deeds are immortalized in song, on canvas or in sculptured stone, whose votes and signatures control the policies of nations and the conditions of mankind, how many engineers are to be found?

The first President of the United States was an engineer. He was not so conspicuous a failure that we need hesitate to try another.

New Sinclair Boiler Plant at East Chicago

Modern Four-Boiler Plant Serving Refinery—Convenience of Operation, Accessibility, Low Labor Requirements and Efficiency Were the Factors Influencing the Design—For Its Size the Plant Is Replete with Instruments

AT EAST CHICAGO, Ind., the Sinclair Refining Co. has been building a refinery that eventually will have a capacity to handle 20,000 bbl. of crude oil per day, piped from the fields of Oklahoma and Kansas. Operations started about two years ago, and the plant is now running at one-half capacity, the present products being gasoline, kerosene, fuel oil, gas oil and wax. Although lighting in the works and the pumping of oil is done with purchased current, a generating plant is in prospect. Steam in large quantities is required for the distillation and treatment of oil, for the operation of auxiliary oil pumps, quenching oil fires, for a 600-ton absorption refrigerating plant that is used to chill the oil in the manufacture of paraffin and for steam-jet vacuum systems removing the ashes from the stills. Of the latter there are four batteries of ten stills each and two ash-handling systems per battery, discharging in opposite directions to concrete pits. In each case the horizontal run is about 130 ft. and the rise to the pit 8 to 10 ft. A locomotive crane with grab bucket transfers the ashes from the pits to railway cars from which they are distributed on the premises for filling.

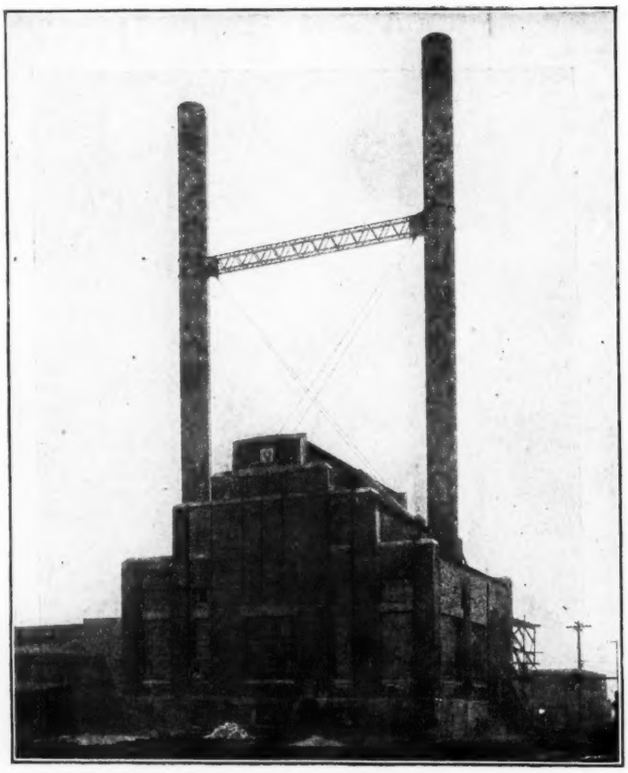


FIG. 1. SINCLAIR BOILER HOUSE AT EAST CHICAGO

To meet this demand for steam, plans were made for a twelve-boiler plant, although the first installation, which is now completed, consists of four units, each a 600-hp. water-tube boiler. The other eight boilers are on order, and it is planned to build a second boiler house containing three 600-hp. units besides a water-softening plant to take care of the water for all of the boilers. The building of six more batteries of stills made this additional boiler capacity necessary. Two boilers are placed on either side of a central firing aisle, and each pair is served by an unlined, painted steel stack, 7 ft. in diameter and 150 ft. high above the grates, located midway between the boilers. The boiler house is a steel skeleton brick building, 61 ft. 4 in. by 73 ft. 6 in. inside in plan and 65 ft. high to the top of the monitor housing the upper horizontal run of the continuous bucket coal conveyor. Steel columns on either side of the central aisle support an overhead coal bunker and, as part of the building construction, an ash tank in line with the bunker. Large glass area in the side walls provides light and ventilation.

Small floor space occupied by the boilers is one of the features of the plant. The actual floor space covered by one 600-hp. boiler is 13 ft. 10 in. deep by 15 ft. 8 in. wide, or 224.5 sq.ft., which reduces to 0.374 sq.ft. per horsepower of rating. Including the boiler overhang and the stoker extension the floor space covered per unit is 15 ft. 8 in. by 23 ft., giving a total of 360 sq.ft., or 0.6 sq.ft. per horsepower.

In the design of the plant convenience of operation, accessibility, low labor requirements and efficiency were

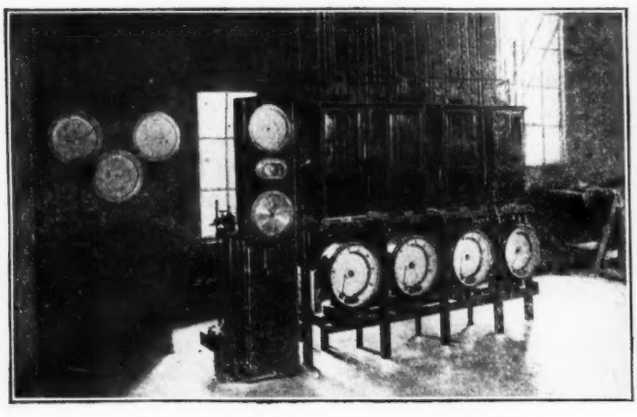


FIG. 2. BOILER-ROOM INSTRUMENTS

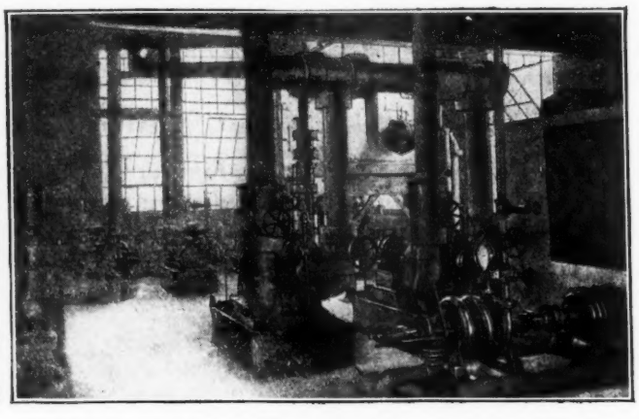


FIG. 3. PUMPING EQUIPMENT OF BOILER PLANT

the factors chiefly considered. Instruments to give all operating data of moment have been installed, and they are mounted centrally at the end of the firing aisle in full view of the operating force. Each boiler, however, has its indicating draft and pressure gages, and for convenience damper control is brought to the front of the setting.

The boilers are set individually in steel-incased settings, with a 5-ft. 4-in. Dutch-oven extension to receive chain-grate stokers having an active grate area of 121 sq.ft. and a ratio to the steam-making surface of 1 to 49.6. On either side the stokers are driven by a vertical engine belted to a lineshaft in the basement, with eccentric and ratchet connection to the stoker gears. Cross-connection between the shafts in the basement adds flexibility to the stoker-driving mechanism.

Headroom of 9 ft. to the center line of the front mud drum gives a furnace volume approximating 6.5 cu.ft. per square foot of grate area. From the apex formed by the intersection of the tubes, the distance to the grate is 9 ft. 6 in. A flat suspended arch 8 ft. long insures strong ignition for the Illinois coal used in the plant. The previous dimension may be compared to 11 ft. of active grate length. The maximum gate opening is 12 in., and at the end of the arch the distance to the grate is 34 in. A sloping arch section at the front, meeting the horizontal section of the arch in conjunction with a grate sloping toward the rear, gives expanding volume for the gases, while still retaining the strong ignition effect desirable with the fuel burned. Thorough mixture of the products of combustion and the air required to burn the volatile is effected by the right-angle turn at the rear of the furnace and a throat between the arch and bridge wall restricted to 42 in. The gases make a single pass across the tube surface to the uptake at one side and at the top of the setting, the outlet measuring 4 x 14 ft. 8 in., or 0.485 sq.ft. per square foot of active grate installed.

A feature of the setting is the installation of the superheater in the combustion chamber back of the bridge wall out of the direct current of the gases, in a free space measuring 3 ft. 3 in. There are 40 elements about 7 ft. high, which are shielded somewhat by the bridge wall, and with tile between the elements there is no circulation of the gases through the superheater. Only the front portion of the U-shaped elements are exposed to the radiant energy of the fire.

Steam of 125 to 150 lb. pressure is supplied to the stills, and the desire was to superheat it about 100 deg. to prevent condensation in the pipe lines. Early operation did not show the desired degree of superheat, but adjustment of the tile between elements has increased the superheat in accordance with the amount of surface exposed.

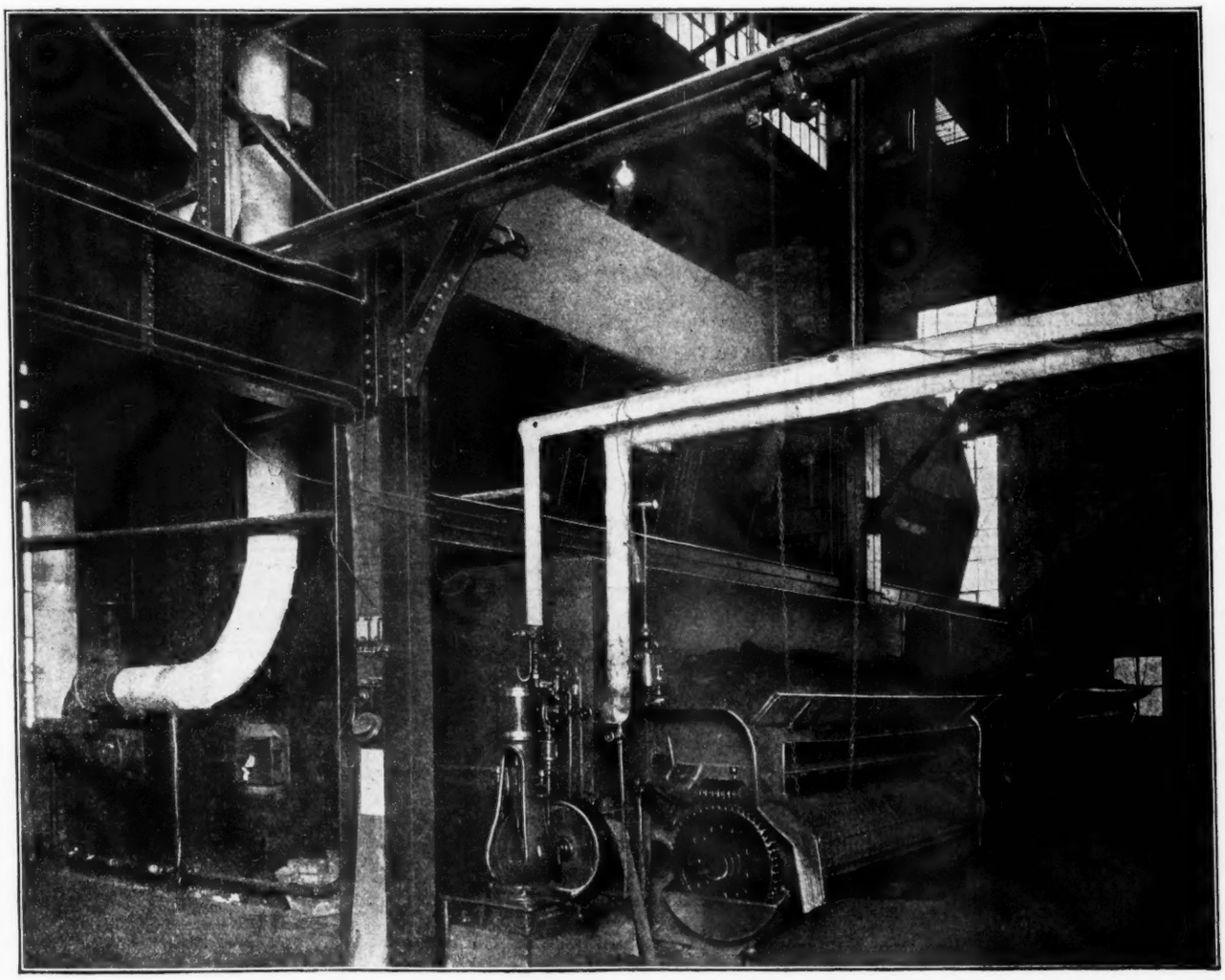


FIG. 4. BOILER ROOM SHOWING TWO OF THE PAGE BURTON BOILERS

It will be noticed that the combustion space is practically self-cleaning. Soot blown off the tubes by the oscillating soot blower onto the fuel bed will pass out with the ash, and from the rear combustion chamber containing the superheater there is direct connection with the ashpit.

At the present writing the steam demand is fairly uniform, running about 50,000 lb. per hour. As shown in the illustrations, the steam is supplied from the top of the main boiler drum to the superheater, thence back to an 8-in. header serving the two boilers on the same side of the firing aisle. Long-radius bends care for expansion. The header on either side joins at right angles an 8-in. main, enlarging to 10 and 12 in. respectively at opposing ends and at present supplying two 8-in. lines to the stills and one 6-in. line to the wax plant. For the most part these steam lines are carried overhead, hung from crossarms on steel poles. The insulation consists of one inch of fire felt and two inches of sponge felt covered by three-ply roofing paper.

Coal comes in over the railway siding serving the boiler room and is dumped into a track hopper from which it passes through a rotary feeder to a continuous bucket conveyor discharging to the overhead bunker. An offset of this conveyor to include the track hopper eliminated the need for the usual auxiliary conveyor. The driving power is a 10-hp. induction belted motor located on the upper run. The conveying system is designed to handle sixty tons an hour. The bunker, of parabolic shape, is supported on steel building columns. It is of the Ferroinclave type concrete lined and plastered outside. The capacity is about 390 tons. Under the bunker the coal is weighed by a traveling larry of 1,000 lb. capacity. A spout on either side leads to the stoker hoppers, the direction of coal flow being controlled by gates in these spouts operated by rods extending to within reach from the floor. Also the weigh beam of the scale is near the floor so that the operator can conveniently weigh and record the coal fed to each boiler. Ashes are stored in a 75-ton reinforced-concrete bunker forming part of the building construction. Delivery to the bunker is made by the continuous bucket conveyor used for handling the coal, and the contents of the bunker are discharged to railway coal cars through a chute leading through the wall. In the basement an industrial track makes the circuit of the four boilers underneath the ash hoppers serving the stokers. Through a circular gate that is hinged to the bottom of the hopper and may be swung easily to one side, the ashes drop into a V-shaped tip car of 27 cu.ft. capacity. They are dumped into a hopper protected by a grid to prevent large clinkers getting through and by means of a rotary feeder passed directly into the continuous conveyor. To prevent air leakage through the ashpit, a handwheel has been provided to press tight the circular gate against its seat.

Cooling water from the still condensers is used as feed water. There is an abundant supply, but owing to

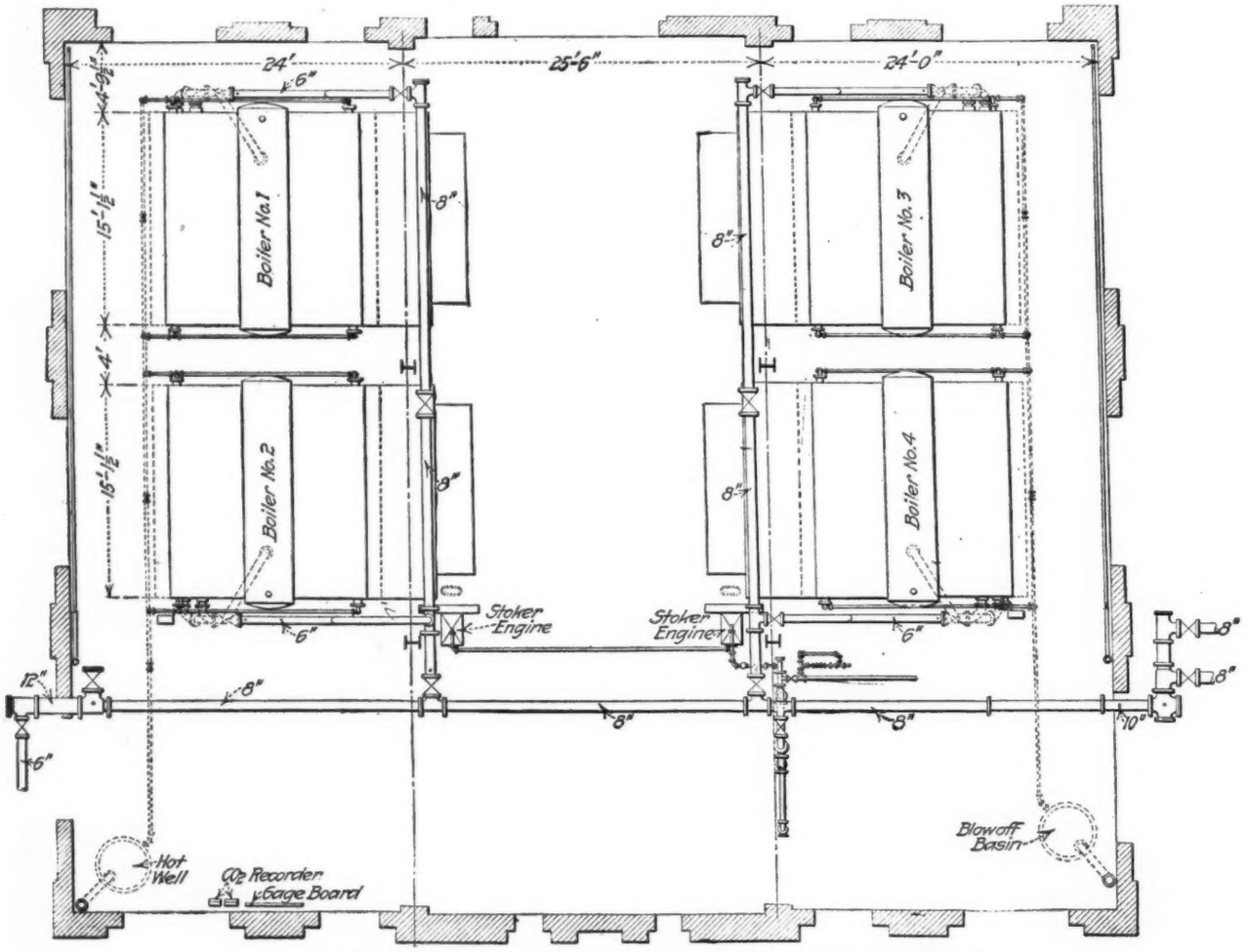


FIG. 5. PLAN OF BOILER ROOM AND HIGH-PRESSURE PIPING

priming troubles a water-softening plant is now under way. The water at a temperature of 120 to 130 deg. is collected in a tank outside the boiler house, 43 ft. diameter and 20 ft. high. By either one of two direct-acting duplex pumps it is raised to an elevated tank in the boiler room, the head in the tank controlling the operation through a pump governor. The tank also has con-

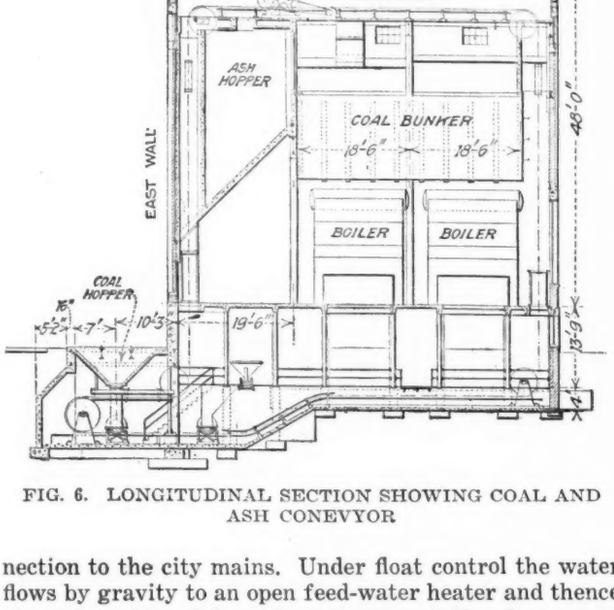


FIG. 6. LONGITUDINAL SECTION SHOWING COAL AND ASH CONEVYOR

nection to the city mains. Under float control the water flows by gravity to an open feed-water heater and thence through turbine-driven three-stage centrifugal pumps to the boilers. An individual regulator at each boiler con-

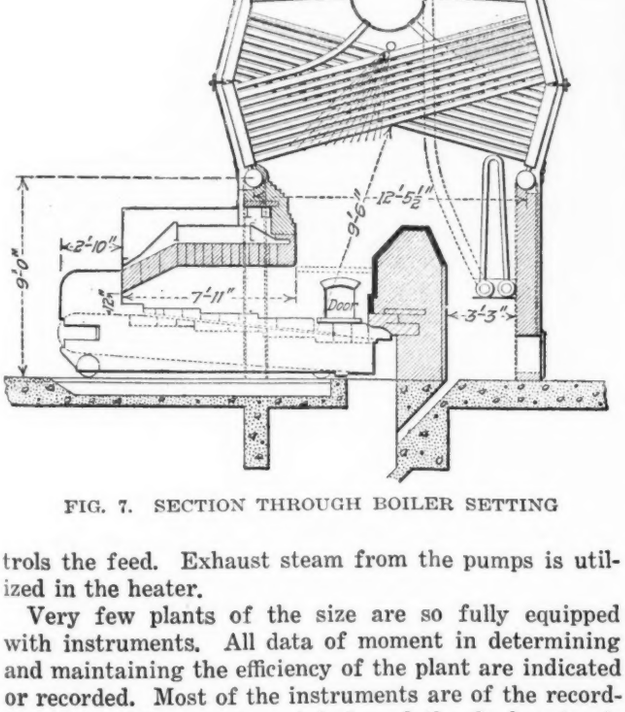


FIG. 7. SECTION THROUGH BOILER SETTING

trols the feed. Exhaust steam from the pumps is utilized in the heater.

Very few plants of the size are so fully equipped with instruments. All data of moment in determining and maintaining the efficiency of the plant are indicated or recorded. Most of the instruments are of the recording type. The coal is weighed, and the feed water is measured by a venturi meter of the indicating, integrating and recording type. For each boiler there is a recording steam-flow meter giving the output. The steam and water meters serve as a check on each other, and the difference in the readings gives the boiler loss by blowing down or by leakage. Steam pressure is indicated by gages on the boilers, and a recording pressure gage

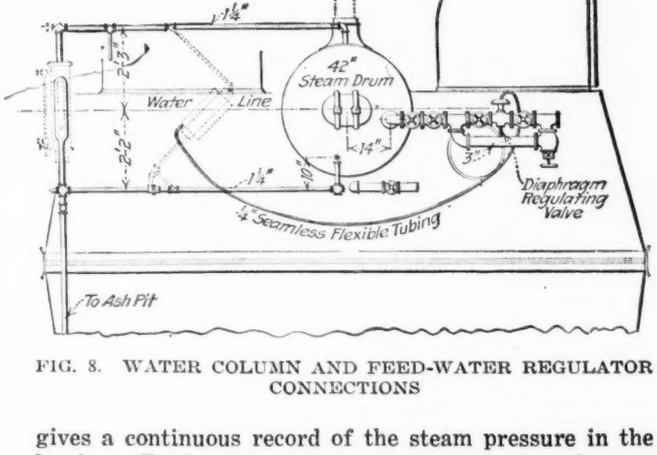


FIG. 8. WATER COLUMN AND FEED-WATER REGULATOR CONNECTIONS

gives a continuous record of the steam pressure in the header. Feed water and steam temperatures also are recorded. Draft over the fire is determined from a draft gage on each boiler, which also give the differential, or drop in draft through the boiler. The efficiency of combustion is indicated by CO_2 recorders. Thus all essential operating data are available, and the recording instruments are grouped on a board at the end of the firing aisle in plain view of the firemen. To maintain maximum economy, there is just one more essential, and this is the proper interpretation and use of the numerous records.

A seven-hour test made on one of the boilers shortly

FIG. 9. SPECIAL GATE AT BOTTOM OF STOKER ASH HOPPER

after the installation had been completed, by Osborn Monnett, consulting engineer, of Chicago, gave some interesting results. With Illinois coal containing over 13 per cent moisture and 12,292 B.t.u. per lb. dry, an equivalent evaporation from and at 212 deg. F. of 9.53 lb. per pound of dry coal was obtained. With a draft of 0.23 in. over the fire and 0.33 in. at the uptake, dry coal was burned at the rate of 25.8 lb. per square foot of grate area per hour. The boiler was operated at 146 per cent of rated capacity, and the combined efficiency averaged 75.2 per cent.

PRINCIPAL RESULTS FROM TEST OF ONE OF THE 600-HP. BOILERS

Avcrage Pressure, Temperatures, etc.

Steam pressure, lb.	124
Feed water temperature, deg. F.	154
Escaping flue gas temperature, deg. F.	627
Draft over fire, in.	0.23
Draft at uptake, in.	0.33
Superheat, deg. F.	35

Total Quantities

Weight of coal as fired, lb.	25,670
Moisture in coal, per cent	13.31
Weight of dry coal, lb.	22,253
Weight of water fed to boiler, lb.	188,836
Equiv. evap. from and at 212 deg. F., lb.	212,252

Hourly Quantities and Rates

Dry coal consumed per hour, lb.	3,179
Dry coal per sq.ft. of grate area, lb.	25.8
Water evaporated per hour, lb.	26,976
Equiv. evap. per hour from and at 212 deg., lb.	30,321
Equiv. evap. per sq.ft. of heating surface, lb.	5.05

Capacity

Boiler horsepower developed	880
Rated capacity	600
Per cent rated capacity	146

Results

Water fed per lb. of coal as fired, lb.	7.35
Water evap. per lb. of dry coal, lb.	8.48
Equiv. evap. from and at 212 deg., lb.	9.53

Efficiency

B.t.u. per pound of dry coal	12,292
Combined efficiency, per cent.	75.2

The plant was designed and erected by home talent, J. S. Hess, chief engineer of the Sinclair Refining Co., being responsible for the design, and R. E. Greenburg, mechanical engineer at the works, having charge of erection.

Reducing Noise and Vibrations

BY K. RANKINE

Substations are frequently located in the midst of residential and business sections of the city, where noise and vibration caused by them is most objectionable. Many cases of litigation have occurred because it has been claimed, and sustained, that the continual hum and vibration of electrical apparatus, destroy the value of property and make dwellings uninhabitable. These lawsuits are expensive for the utility and are injurious to its interests, because public good will is an asset of value if an intangible quantity. Unfortunately, it is rather difficult to determine beforehand whether a substation will be noisy and vibrate or not. The following discusses some of the pertinent factors that tend to reduce, if not actually eliminate, noise and vibration.

Noise is often the result of vibration. For example, it is the motion or vibration of loose iron laminations that starts the humming noise so characteristic of some electrical apparatus. On the other hand noise may occur without vibration, as the singing or whistling due to windage with rotating machinery such as synchronous converters and motor-generator sets. The manufacturers of electrical machinery, both rotating and static, have done much to prevent noise and vibration. They have largely done away with loose laminations and rattling parts; they have designed pole tip and air gaps that hum but slightly, notwithstanding the higher flux densities now employed, and that give rise to only slight windage. Nevertheless, it is sometimes necessary to partly or even totally inclose rotating machinery located directly in residential districts. Inclosing apparatus, while interfering with its natural cooling, and therefore ability to dissipate heat, offers the opportunity to employ forced ventilation and in this way avoid noise due to the machine and at the same time increase its current-carrying capacity. There is little doubt that this practice could be developed much more than it has been in the past.

While the manufacturers have gone a long way toward producing noiseless equipment, the entire responsibility in this connection does not devolve upon them. The operator and those who design the building to house the machinery are also responsible in a very large measure. In fact, there is much greater opportunity for making operation quiet and free from vibration in the design of building and foundations than there is in the design of the equipment. Unfortunately, the average architect knows little about electrical machinery and what precautionary measure should be taken against noise and vibration. However, the methods of reducing noise and vibration are simple if carried out at the time the building is constructed.

Windows offer a ready means of escape for noise, hence their number and area should be kept to a minimum, and needless windows omitted. The noise passing through openings in the roof will cause less disturbance and be less noticeable than noises that pass through windows in the substation walls. The farther the windows are away from the machinery the better. They should never be located in the direct path of air currents resulting from heat losses, forced draft or windage of rotating machinery, as the noise may be exaggerated and distributed farther.

If the walls of substations located in residential zones are built double with a dead-air space between them they will cushion noise and also vibration to some extent. The heating required during cold weather should also be less. Where forced or mechanical ventilation is used, as for inclosed synchronous converters and air-cooled transformers, special care should be taken that the discharging air shall not be so routed as to act as a carrier for noise.

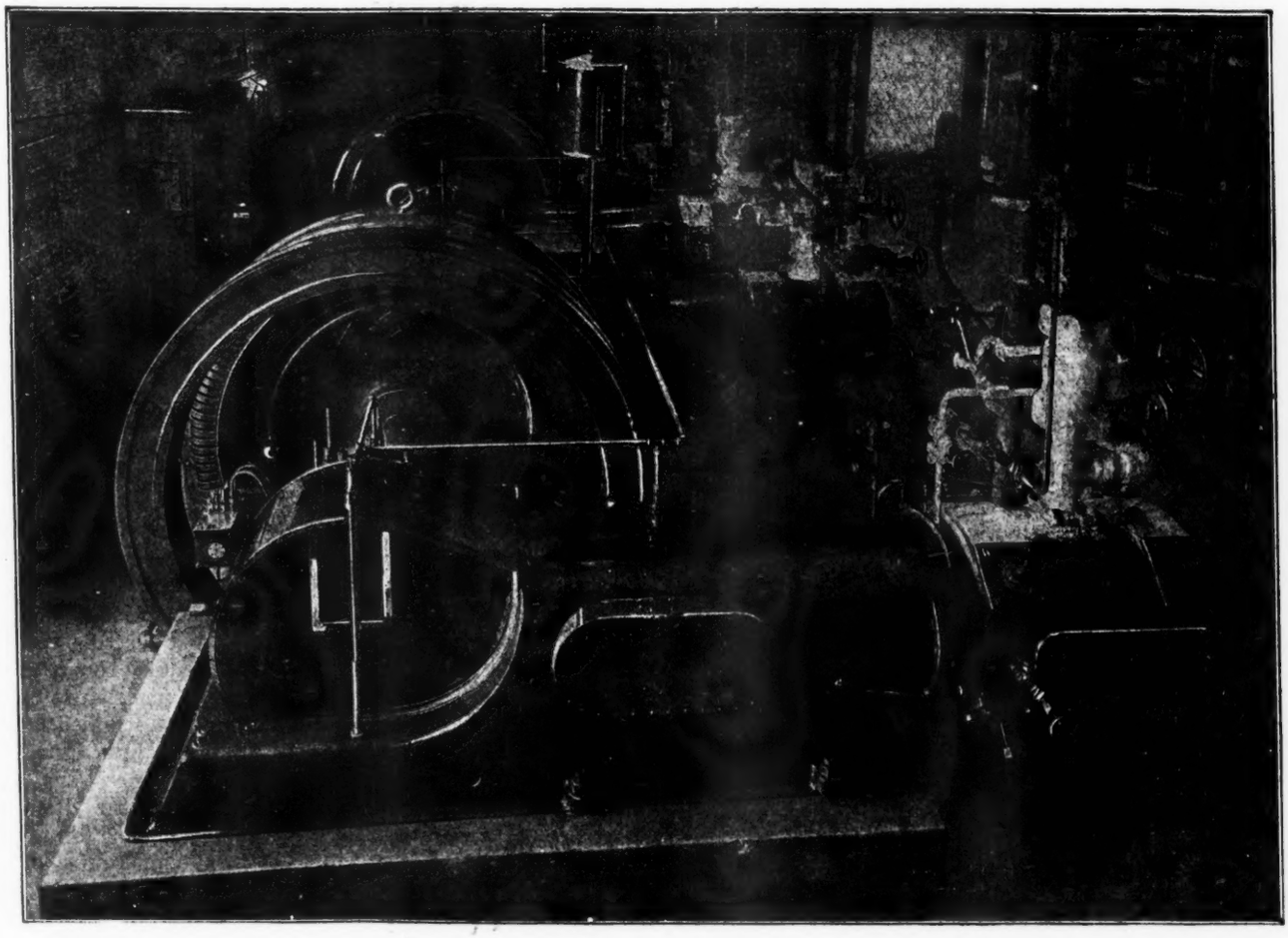
Vibration can be reduced by paying special attention to foundations and the manner in which apparatus is placed upon them. It is sometimes a good plan to isolate the foundations from the station structure by sinking the machinery foundation separate from that of the building. Floors, etc., should not make physical contact with the foundations, a two-inch gap being left all around the latter. In this way vibration is not transmitted to the station structure and from there beyond. One frequent cause of vibration troubles results from the fact that the vibration of machinery is transmitted to girders and beams and the periodicity of vibration of the one sets up a condition with the other where the effect becomes cumulative. The more massive the station foundations the less the probability of vibrations being transmitted and becoming cumulative. However, the more substantial the foundations the greater their cost, which means that common sense precautions are less expensive than solution by mass and weight only.

In addition to the very general phases of this matter of noise and vibration, there are the more specialized problems that may call for noise-proof rooms, pads installed underneath induction regulators and transformers, etc. These are, however, matters that can usually be taken care of later, after the other precautions have been incorporated in the design of the substation. Only by familiarizing the architect with the inherent characteristics of electrical apparatus and the specific conditions that it is desired to guard against, can success be expected. In far too many instances the architect knows too little about what the building is to house, and expensive changes, litigation and endless troubles result.

Practical Refrigeration for the Operating Engineer—Regulation of Pressures and Temperatures

By B. E. HILL
Formerly Refrigerating Engineer, Armour & Company, Chicago

THOSE responsible for the operation of refrigerating machines are aware that to reduce the temperature of a cooler or freezer to zero or below, it is necessary to lower the suction pressure to the compressor; but as I have found many engineers who do not understand why this is necessary, an explanation will be welcome, as these articles are for the benefit of the operating engineer and not the college graduate or professor, although the practical knowledge of operation which I am endeavoring to convey will be beneficial to the college man as well.



HIGH-SPEED, MOTOR-DRIVEN AMMONIA COMPRESSORS IN A MODERN REFRIGERATING PLANT IN NEW YORK CITY

A modern high-speed, motor-driven ammonia-compression plant is shown herewith.

The properties of saturated ammonia, as referred to, will show the engineer the boiling point of liquid ammonia for any required suction pressure, and when it is required to reduce the temperature of a freezer to, say, 20 deg. F. below zero, it will be easy to understand that the temperature of the boiling liquid on the inside of the pipes that are placed in this freezer will have to be reduced below the temperature of the room. By referring to the tables previously mentioned it will be found that the boiling point of liquid ammonia at zero pounds pressure, or atmospheric pressure on the suction or low-pressure gage, will be 28½ deg. F. below zero, which is only 8 deg. F. below room temperature.

From the foregoing the operating engineer will readily see why it is necessary to reduce the suction or low pressure to produce low temperatures, and also he will find a good reason for ammonia getting *lost, sluggish* or *hiding.*

When the temperature of a cooler or freezer is only about eight or ten degrees above the boiling temperature of the liquid ammonia on the inside of the expansion or evaporating coils, the engineer can expect nothing except a slow or "sluggish" evaporation. Do not swear at the man who sold you the ammonia for selling you an inferior quality or a kind of ammonia that will not mix with what you already had, etc.; but look for the cause. If the temperature is not holding

or coming down as it should, the cause is generally due to slow evaporation, as already explained, a shortage of ammonia in the system, not enough pipe surface in the cooler for the product to be handled, and many other causes which we will treat later.

The evaporating coils are the boiler of the refrigerating plant, and the engineer or temperature man should watch the return end of the coil the same as he watches the water glass on the boiler. Examine the return end and apply the stick test, as before explained, before feeding up or cutting back the expansion or feed valve, and there will be little or no trouble from overfeeding and slugs.

Duties of the Temperature Man

In large plants where there are thousands of feet of direct-expansion pipe and hundreds of expansion valves, it is necessary to employ a temperature man, whose duty it is to regulate these valves, take temperatures, etc., and report them properly made out on a temperature or log sheet, which enables the engineer to properly direct and operate the plant.

In plants where several temperature men are employed, there are times when it is necessary to "break in" new men on this work, and at such times there is always more or less danger of overfeeding the expansion coils and the accompanying danger to the compressor, together with alternate "freezing up" and "burning up" of the compressor, which also carries with it an unusual loss of ammonia due to expansion and contraction of the piston rod, packing, joints and connections.

Most steam plants use a separator between the engine and boiler to protect the steam cylinder from water, and for the same protection to the ammonia compressor, there should be a separator between the evaporating coils and the compressor, as there is no difference in the results other than a much greater need for a separator on the suction line leading to the compressor, as the danger to life and property are many times greater in case a compressor head is knocked out, due to suffocation from ammonia gas, fire, etc., which subjects will be treated later.

It is necessary only to secure an ordinary steam separator, preferably one having a storage capacity, for liquid, so that in case of liquid being carried over to the compressor from overfeeding the evaporating or expansion coils, the storage capacity in the separator will give time for the liquid to drain back to the evaporating coils, or other means so provided for the purpose.

Installing the Separator

The separator should be installed at a point high enough above the evaporating coils to insure a speedy drainage of the separator, also the drain line should be provided with a valve to close in case of pumping out.

The drain line from the separator can also be connected to a tank located below the separator for the liquid to drain into. This tank is provided with a water jacket, with steam connection to keep the water hot for the purpose of reëvaporating the liquid ammonia, the gas piped back to the suction side of the compressor; and in this way the tank serves the double purpose of converting the liquid from the separator into a gas and purifying the ammonia by separating out the oil or water that may have been taken into the system by leaks or inferior ammonia and the oil that works into the system from the compressor.

When the liquid from the separator is carried back to the evaporating coils, there is practically no loss from this source, as the liquid is reëvaporated and will do useful work in the transfer of heat, but the beneficial results of leading the separator drain to a purifier will more than offset the gain by the other method of reëvaporating the liquid in the coils.

Another system for removing liquid from the separator is to connect the drain line to an automatic drip tank and pump which is operated with a float and returns the liquid to the expansion or evaporating coils, the operation being the same as that used in a steam plant for returning condensate to the steam boiler.

The frost on the suction line leading to the compressor does not mean that there is liquid ammonia being carried over to the machine, for the reason that the gas is in a saturated condition and is at the same temperature as that of the boiling liquid. If the boiling liquid is below the freezing point of water, it will freeze the moisture that is carried in the air which comes in contact with the cold surface of the pipe, forming a coating of frost of a thickness depending upon the saturated condition of the air, temperature of the ammonia, gas, and time.

On all horizontal double-acting compressors it is good practice to "freeze back" to the machine, as the heat of compression is much greater than in the single-acting compressor.

Few Plants Are Free From Decomposed Ammonia

Ammonia (NH_3) is decomposed by heat, and it is claimed by some authorities that a complete separation of the nitrogen and oxygen takes place at a temperature of about 900 deg. F., while others claim that decomposition takes place very slowly, at a much lower temperature, ranging from 150 to 300 deg. F. There are few plants that are entirely free from decomposed ammonia. There may not be enough to noticeably affect the capacity of the plant, but nevertheless it is there in greater or lesser quantities, and for this reason alone, the frost should be carried close enough to cool the gases, leaving the machine to a temperature of 100 to 150 deg. F., which can easily be determined by inserting a thermometer in the discharge line of the compressor.

Another reason for holding the temperature down on the discharge line, is to prevent vaporizing of oil which, if carried to the oil trap at a temperature of from 300 to 500 deg. F., will be in a more or less vaporous or finely atomized condition and will float with the hot gas to the ammonia condenser where it will be condensed to a liquid, then go on to the evaporating coils where the oil congeals more or less, depending on the freezing point of the oil. When the coils accumulate enough of this oil it will cut down the refrigerating effect of the ammonia, as it is a good insulator, and will also stop up the feed or expansion valves to such an extent that regularity in the feeding of the coils will be impossible; often the coils stop up altogether, which necessitates a shutdown for cleaning out the system.

In large plants it is often necessary to run suction lines for a distance of 300 to 600 ft. and even longer, and in such cases it is difficult to freeze back to the compressor with any degree of regularity owing to a large number of crooks and turns, risers, drops, radia-

tion, etc. In such cases it is more effective and less dangerous to cool the compressor by connecting a ¼-in. line from the liquid receiver and expand direct into the suction line at a location somewhere close to the compressor.

In traveling these long distances, there are considerable losses due to radiation, as the insulation is never perfect enough to prevent these losses. To successfully cool the compressor or "freeze back" through these long lines requires considerable practice. If there is oil in the system, as mentioned, it is impossible to cool the gases leaving the compressor with any degree of regularity. It will be a feast or a famine. The compressor will either get the ammonia in "chunks" or will be "burning up," together with all the other interesting conditions caused by irregularities in the handling of expansion valves. It is a great deal more safe, sane and economical to bring bad conditions close up under the watchful eye of the operating engineer, than to trust to Providence and the temperature man not to blow the place up.

Selection of Lubricant

In the selection of an oil for use in the ammonia compressor it is important that the selection be made with a view to securing one with the highest flash point, greatest viscosity and lowest congealing point. The best is none too good as regards the points mentioned, and a question of price should not enter into the proposition at all, as the effect caused by the use of an inferior grade of ice-machine oil will offset the difference in price many times over.

The engineer should get samples of as many grades of ice-machine oils as he can from the local dealers and have analyses made of them and make his selection from the information so derived. If it is not convenient to get this information from a laboratory, he should insist on the dealer giving it to him.

A good grade of paraffin oil, with the wax as nearly completely removed as possible, will make a good ice-machine oil. The more paraffin wax the refinery removes from the paraffin oil, the lower will be the congealing point, which ranges somewhere around 15 to 18 deg. F. below zero.

The engineer should never under any circumstances allow engine oil to be used in the compressor or on the compressor piston rod.

As a guide to the engineer who is not familiar with the physical properties of ice-machine oils, the writer will refer to a table showing the essential properties referred to.

PHYSICAL TESTS OF OILS

Kind	Specific Gravity	Viscosity	Flash Deg. F.	Fire Deg. F.	Congealing Point Deg. F.
Arctic ice-machine oil.....	0.8920	3.93	372	399	—19
Ice machine.....	0.8746	3.93	368	392	—24
Ice machine.....	0.8912	3.225	320	360	—20
	0.9258	4.18	330	360	—26

In the application of ice-machine oils as a lubricant, the writer has failed to find a single case in thirty years of actual operating experience where it was necessary to pump oil directly into the compressor cylinder.

Twenty years ago nearly all of the well-known ammonia compressor builders equipped their machines with oil pumps and piped them to pump oil into the compressor cylinder direct, as well as into the stuffing-box between the packing; but today oil is pumped to the stuffing-box only, and in many cases a sight-feed oil cup is placed over the piston rod, allowing the oil to be fed in drops, with a moderate feed, which is found to be ample lubrication for both packing and compressor.

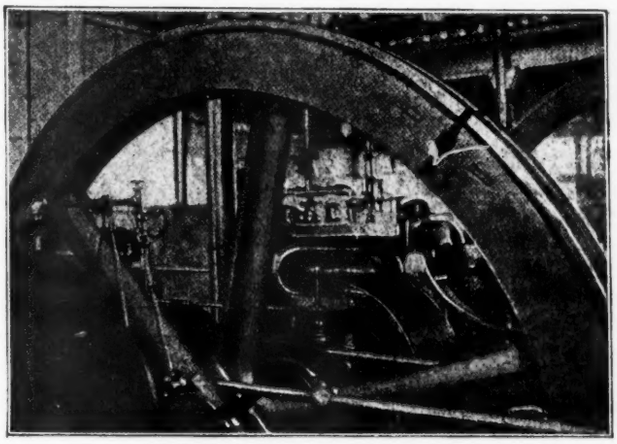
The oil that adheres or sticks to the rod is carried inside and is wiped off inside the compressor cylinder. I have experimented along these lines considerably and have yet to find a single case in which, where the oil cup was used, the compressor has shown signs of wear due to insufficient lubrication.

The only excuse for an oil pump being connected to the stuffing-box at all is to give the packing a "shot" of oil to stop the rod from leaking, when the packing has been allowed to remain in use so long that it will not hold, or a quick change of temperature caused by overfeeding of the evaporating coils.

The engineer will find by an examination of the system at the end of the season's run that there will be "oil aplenty" in the evaporating coils and will find also that it will be a good paying investment to clean them out thoroughly at least once a year.

Flywheel Failure Is Harmless

The illustration shows a nine-foot flywheel (which was used in connection with a refrigerating engine) after a disruption due to centrifugal force. The hub and arms of the wheel were so badly fractured that it was a total loss. Luckily, no other damage resulted, as one of the employees happened to be near the throttle and closed it as soon as the engine began to race,



THE FLYWHEEL AFTER DISRUPTION

thereby preventing complete destruction of the wheel and possible damage to surrounding apparatus and property and loss of life. Considerable velocity must have been gained by the rim before the throttle was closed, as the links forming the rim joints had stretched ful'y an inch. This was caused by the tendency of centrifugal force to separate the halves of the wheel.

The strain on the hub-bolts was so great when the links began to stretch that two of them sheared off, the hub itself split in two and one of the arms was completely separated from the rest of the wheel.

The Board of Trade of Alberta, Canada, has appointed a committee to investigate the possibilities of the waste coal from the mines, in the generation of electricity in a large central plant and of proper distribution of this power to manufacturers and municipalities near-by.

Electric Motors for Pulp and Paper Machinery Drives

By WILLIAM H. EASTON
Industrial Engineer, Westinghouse Electric and Manufacturing Company

The advantages of electric drives in pulp and paper mills are discussed, and the characteristics of the different types of motors and the kind of controllers used on the various drives are considered.

ELECTRIC motor drive is generally favored today for driving pulp and paper machinery because it can produce better results than any other form of power. A wood-pulp grinder, for example, can produce more and better pulp when motor-driven than when driven by a waterwheel. The reason for this follows:

There is one speed, and only one, at which the best results can be obtained. Should the speed be lower than this, production falls off; should it be higher, the quality of the pulp suffers from excess of splinters and short fibers. The speed of a motor, of either induction or synchronous type, is inherently more nearly constant, especially under wide variations of load, than that of a waterwheel; therefore, when the girder is motor-driven its speed can be kept close to this most efficient value at all times, whereas with waterwheel drive there is bound to be considerable variation above and below this speed, with detrimental results. The foregoing holds true for beaters and jordans. Motor drive also makes it possible for the operator to obtain complete information as to operating conditions. The power taken by these machines depends upon a number of factors, such as the position of the roll or plug, the character of the stock, the degree of refinement of the stock and the condition of the bearings. Hence, by driving each machine with a separate motor and connecting an ammeter (especially a graphic instrument) in the circuit, the operator is provided with a guide which, after a little experience, enables him to adjust the machine to produce exactly the desired results, stop the refinement at the proper moment, prevent impending trouble due to worn bearings, and control the operation in other ways.

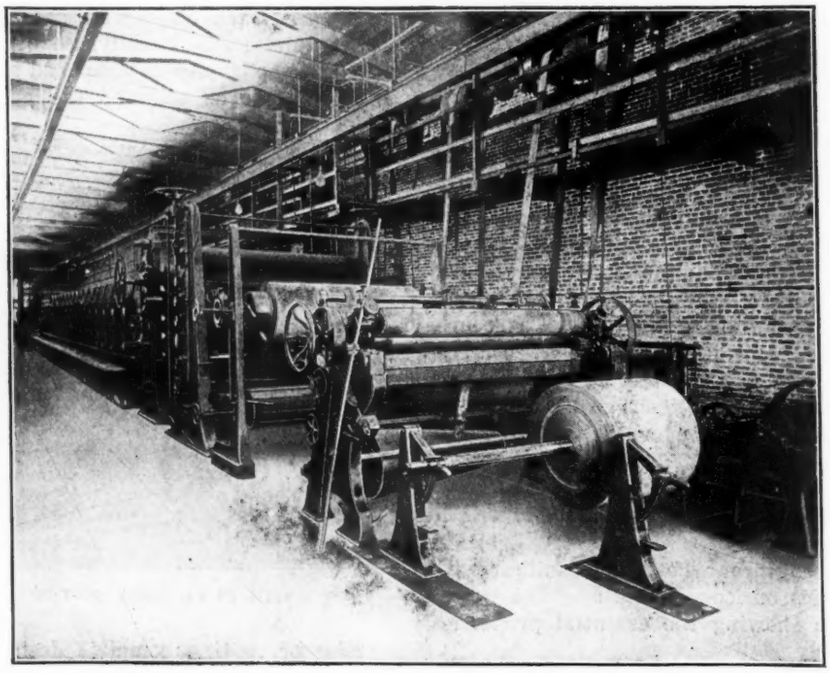


FIG. 1. MOTOR DRIVEN PAPER MACHINE

A special advantage of motor drive for jordans is that with a direct-connected motor there is no side thrust on the bearings as there is in belt drive, consequently the plug does not acquire eccentricity, which decreases the efficiency and wastes power. For the paper machine, motor drive has been revolutionary. It has freed the machine from all complication of transmission and speed-changing mechanism, and made possible its control with the utmost nicety, over a wide range of speeds, by merely pressing a few buttons.

The super-calender, too, has gained greatly by motor drive. When belt-driven, it has but two speeds, a low one for threading-in and a high one for running. It is difficult to change from one to the other without tearing the paper, and since the running speed exactly suits but few grades of stock, much of the work must be run off at too low a speed for efficient production or too high to produce the best results. With motor drive any range and any desired number of speeds can be obtained and the transition from low to high is smooth and even.

Motor drive, as compared with direct water drive, permits complete freedom of choice in the location of the mill. Water power can be used more efficiently to drive a few large generators under skilled supervision than to drive a number of small wheels throughout the mill. Then, too, if motor drive is used, steam auxiliaries or central-station power can be used during periods of low water. With steam or water drive, the location of the lineshafts fixes the positions of the machines, and additions are awkward to make and often result in a complicated and inefficient power-transmission system.

The working conditions in a motor-driven plant are much better than in those using lineshafts. There is better light, greater cleanliness and, especially, greater safety, since all dangerous belts and pulleys can be eliminated, all necessary transmissions can be inclosed in guards, and hazardous machines, such as super-calenders, can be equipped with numerous safety stops so that they can be shut down instantly from any point in case of accident.

Alternating current is almost invariably used in pulp and paper mills because it can be transmitted economically from a distance and also because alternating-current motors, due to their simple and sturdy construction, are better adapted to the majority of pulp and paper machines. Although the paper machine and the super-calender are best driven by direct-current motors, it is in general more satisfactory to use alternating current for most of the drives and generate direct current specially for these machines. It is, however, perfectly possible to drive small paper mills by direct current as is being done in a number of instances.

Where the mill generates its own power, it uses water power if possible, entirely or in part, and steam turbines where steam power is necessary. Because of the large amount of exhaust it is frequently a better plan, in cases where the entire supply of exhaust steam is not always utilized (as in summer), to install bleeder turbines.

Many old mills have changed over completely to electric drive and have more than justified the expense by increased earnings; but where there are engines that are satisfactorily driving some of the larger machines, it is sometimes good economy to allow them to remain and use electric drive for the other machines, thus getting rid of the small inefficient engines and simplifying the transmission problem. Central-station power is frequently very useful in taking care of these supplementary drives; but if the engines retained produce an excess of exhaust steam, a low-pressure turbine-generator can be installed to utilize this excess and produce a part or all of the supplementary power in a very economical manner.

For the general run of pulp and paper machinery the squirrel-cage and wound-rotor motor types of alternating-current motors are used. The squirrel-cage type of machine is the simplest motor made, because of the

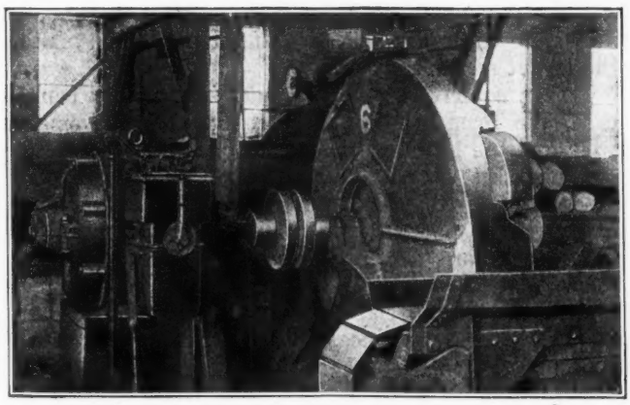


FIG. 2. FIVE-FOOT BARKER DRIVEN BY 15-HP. SQUIRREL-CAGE MOTOR

small amount of care it requires, absence of sparking, and its ability to work in dirty and dusty places (although, of course, it must be kept as clean as possible). Its two limitations are, that it is a strictly one-speed machine and that it takes a large current when starting under load, which is frequently undesirable, especially with motors of large size.

The wound-rotor motor is used wherever either of these two limitations prevent the use of a squirrel-cage motor. It is similar to the latter in construction except that its rotor carries an insulated winding, connected to slip rings on the rotor shaft. By means of these slip rings, resistance varied by means of a controller can be introduced into the rotor circuit. By varying this resistance two things can be accomplished: The motor can be started under full load and brought gradually to full speed without drawing at any time more than 50 per cent excess current from the line. Secondly, a certain amount of speed variation can be obtained, which is satisfactory over a range of

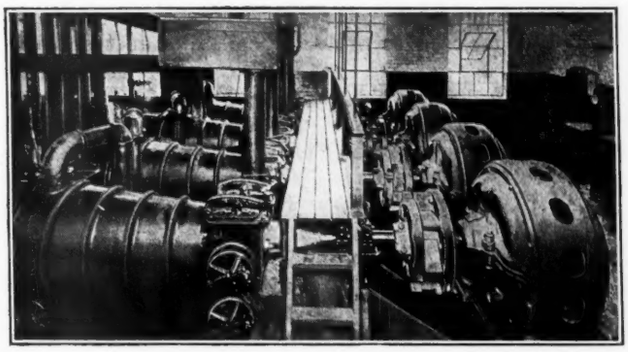


FIG. 3. JORDANS DRIVEN BY 125-HP. SQUIRREL-CAGE MOTORS

(1) from normal speed to about 50 per cent below normal, for applications where the torque falls off as the speed decreases, as in fans; and (2) from normal to about 10 per cent below, for applications where the torque remains fairly constant at all speeds, as with the paper machine. In the latter case low speeds are unsatisfactory because too much current is consumed in the resistance for economical operation and because it is frequently impossible to obtain exact and stable speeds on the various steps.

In the early days a wound-rotor motor could be used for both heavy-starting constant-speed service and for variable-speed service, but with refinements in design, these motors are now specially constructed for each service and the two types are not always interchangeable.

For machines requiring speed variation, therefore, a wound-rotor motor will be used without question; but for constant-speed machines that require high starting torque, the choice depends on conditions. Some central stations will not permit squirrel-cage motors larger than 15 hp. on their lines. But where the current is supplied by a private plant, the limit of size of a squirrel-cage motor depends mainly upon the size of the generating equipment, the capacity of cables, transformers, etc., and the amount of trouble caused to lights and to other machines when the squirrel-cage motor is started. It is, therefore, impossible to be specific as to the proper selection of these motors for use on various pulp and paper machines, but the following can be considered good practice:

Screens of all types, saws, barkers, deckers, platers, pumps, agitators, rag cutters, dusters, threshers, rotary boilers and cutters may all be driven by squirrel-cage motors when driven either individually or in small groups. Wound-rotor motors may be used to drive large groups of machines of any type, bandsaws, conveyors and log hauls, chippers, sheet calenders and shredders.

Shredders, rag cutters and chippers are sometimes driven by a special type of squirrel-cage motor with high-resistance rotor end-rings. The effect of the use of this resistance is that, when the load increases above normal, the motor slows down and exerts a very high

torque, which is desirable with these machines in case of jamming. The efficiency of the motor is, however, not as high as that of the standard motor. With squirrel-cage motors, simple inclosed starting switches are used for sizes up to 5 or 10 hp. and compensators for larger sizes. Drum-type controllers are used with wound-rotor motors, with resistors for either starting or speed-control service, as required.

Direct-current motors can be used for all the foregoing applications, but they must be in general partly or totally inclosed to protect them from dust and dirt and to prevent the commutator sparks from setting fire to combustible material. In order to realize all the advantages of motor drive the various machines listed herein should be individually driven; but it is frequently more economical to arrange similar machines in small groups and drive each group by a single motor.

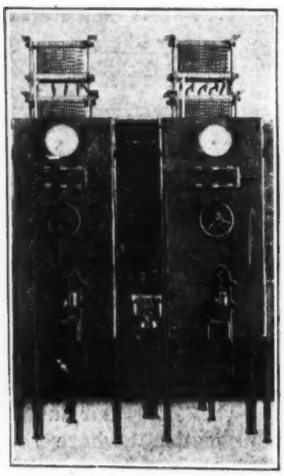


FIG. 4. CONTROL PANELS FOR STARTING 150-HP. BEATER MOTOR

Wood-pulp grinders are coupled to the motor either singly or in a group consisting of as many as five. Where there are two grinders per motor, the grinders are usually located on both sides; and where there are four, it is good practice to place two on each side of the motor. But sometimes all the grinders are driven from one side of the motor. Flexible couplings should be used between the motor and the grinders to relieve the motor shaft of the weight of the stone. The usual speed of a direct-connected motor is about 240 r.p.m., and the power per grinder ranges from 400 to 1,600 horsepower.

Squirrel-cage motors are occasionally used where grinders are individually driven, but usually wound-rotor motors or synchronous motors are employed. The synchronous motor is, however, rapidly superseding all other types because of its constant speed, high efficiency and ability to keep the power factor of the system high. Owing to these advantages there is a growing tendency to use synchronous motors for industrial drives wherever possible, but in pulp and paper mills the drives for which the synchronous motor is suitable are limited.

During the process of grinding there is a considerable variation in the pressure on the stone, because the pressure will change when a new log is inserted and its face is being ground down to the contour of the stone. This variation in pressure produces variations in the quantity and quality of the product and also causes variations in the amount of power required. This latter condition is especially objectionable when central-station power is being used, since many central stations charge according to the maximum, and not the average, demand. Hence, the elimination of high peaks reduces the cost of power.

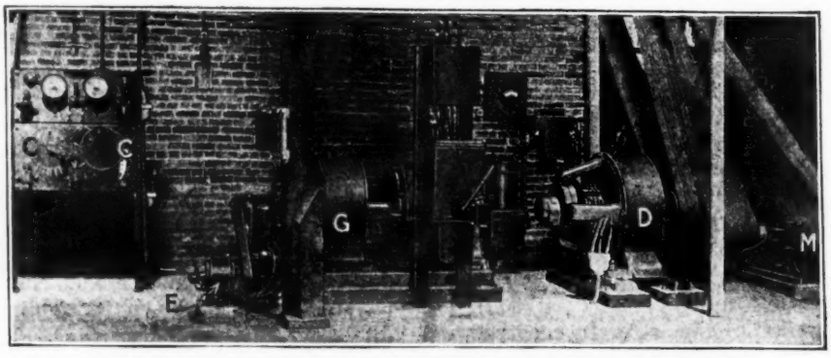


FIG. 5. MOTOR DRIVE AND CONTROL FOR PAPER MACHINE

An automatic pressure regulator is now being used with individually motor-driven grinders, which keeps the pressure constant at all times, thus improving production and lowering power costs. It consists of two magnetically operated valves which control the admission of the hydraulic pressure to the grinder cylinders containing the logs. The magnets are actuated by relays controlled by the current taken by the motor. When this current exceeds a predetermined amount, the proper relay closes and energizes the valve that reduces the pressure; and when the current falls below a predetermined lower level, the other magnet is similarly energized and the pressure increased. With normal current there is no pressure variation.

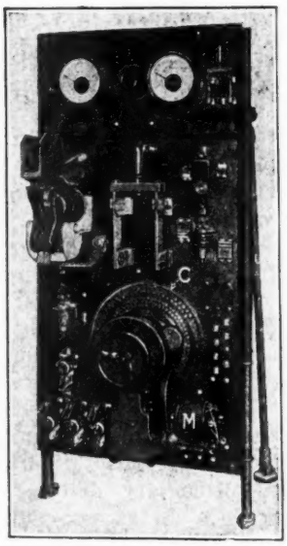


FIG. 6. FULL AUTOMATIC CONTROL FOR PAPER MACHINE

Beaters can be driven in pairs by motors with double extended shafts, but it is better to use individual motors because of the flexibility of the arrangement and the possibility of using ammeters to provide information as to the operating condition. Belts, chains and rope drives are used. Chains are more efficient, but belts and ropes allow some slippage, which is often desirable, especially in heavy duty. On the other hand, chains permit the motors to be brought close to the beaters, thus making the layout more compact.

Either squirrel-cage or wound-rotor motors can be used, the former being more common in the smaller sizes and the latter in the larger sizes. If the motors are installed in the beater room, where they are exposed to dampness, their windings should be impregnated, but this is unnecessary if they are located in an adjoining room or on the floor below and drive with long belts or ropes. The horsepower requirements vary not only with the size of the beater, but with the character of the stock — rags taking several times the power needed for sulphite pulp, so that the range of motor sizes per beater is from 30 to 200 horsepower.

Jordans are always driven with the motor directly connected to the plug through a flexible coupling. In order to adjust the

position of the jordan plug for light or heavy work, either the entire motor is arranged to slide horizontally together with the plug, on its baseplate, or the motor remains fixed and a telescopic coupling is used. Either squirrel-cage or wound-rotor motors can be used. Synchronous motors can also be used where power-factor correction is desired. The horsepower requirements range from 75 to 300 hp., and the motor speed is about 350 revolutions per minute.

The earliest and simplest motor drive of the paper machine was to use a constant-speed motor, almost invariably of the squirrel-cage type, to drive the constant-speed end of the machine, and a similar one to drive the variable-speed end, the speed variation of the rolls being obtained by the ordinary mechanical means. This, however, merely simplified the transmission to the machine, and an attempt was soon made to simplify the mechanism of the machine by using a variable-speed wound-rotor motor for the variable-speed end. Experience shows that when a speed range of not more than 10 per cent is required, this method is satisfactory, but it is not applicable for wider ranges.

The next step was to use a constant-speed motor, as before, for the constant-speed end, but to substitute for the wound-rotor alternating-current motor on the variable-speed line, one with much better speed characteristics, namely, a direct-current motor with field control. This usually involves two kinds of current in the mill, but the advantages more than offset the complication. The variable-speed line is operated by a motor with a speed range of from one to three, with any number of steps within this range, and the speed on each step can be accurately maintained regardless of any variation in the load, which is not the case with the wound-rotor motor. Hence, it is a considerable improvement over the earlier drives.

It has, however, several objections, except for certain limited applications. The direct current is, of course, obtained from a general-power circuit, supplied ordinarily by a rotary convertor or a motor-generator set and serving, perhaps, several paper machines, super-calenders, etc. But each paper machine requires so much power that whenever one is started or stopped, the speed of every other machine on the line is temporarily affected, which is, of course, detrimental. In addition, since the power required by the machine varies with its speed, its driving motor will be much too large, therefore inefficient at low speeds, in order to provide sufficient power at high speeds. Finally, the speed range of 1 to 3 is not sufficiently large for machines running off a variety of stocks, and while a different set of speeds can be obtained by changing pulleys, this is necessarily awkward and time-consuming and will rarely provide exactly the right combination of speeds. Hence, further development was necessary, which resulted in the present fully developed paper-machine drive.

In this drive the constant-speed end of the machine is driven, as always, by a constant-speed motor *M*, Fig. 5, and the variable-speed line by a direct-current motor *D* with speed adjustment by field control, as in the last method; but a new element is added in the form of a separate direct-current generator *G* for each paper machine. The special feature of this generator (which can be driven in any desired way, but preferably by a synchronous motor) is that it is separately excited by a small exciter *E*, the motor also being separately excited by the same exciter. By varying the current supplied to the main-generator field, the delivered voltage can be varied; thus the speed of the motor driving the paper machine can be varied over a wide range, and motor speeds above normal can be obtained by means of field control. The combination of these two methods, therefore, provides an ample speed range of about 10 to 1.

In the fullest development of this system the control is centered in push-button stations, which can be located at any desired points around the machine. There is also a speed indicator which reads in feet of paper per minute and is actuated by a magneto mounted on the shaft of the paper machine.

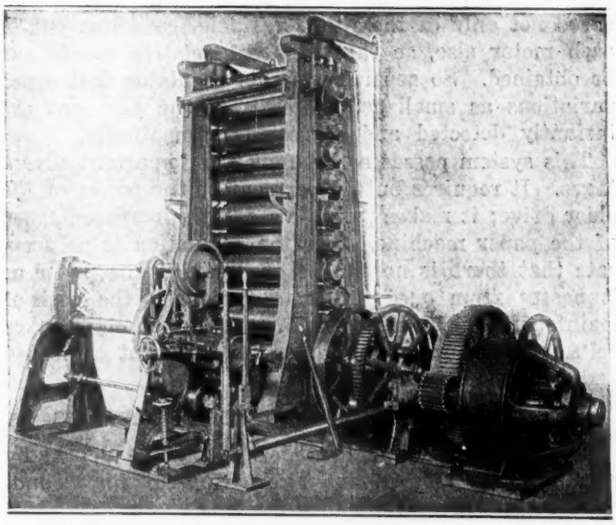


FIG. 7. SUPER-CALENDER OPERATED BY SINGLE DIRECT-CURRENT MOTOR

When the operator presses any one of the "start" buttons, a magnet-switch starter, Fig. 6, automatically starts the motor and accelerates it to a low speed. The "fast" button is then pressed and a little motor, *M*, mounted on the main-control panel (which is located near the motor) begins to move a rheostat arm around a series of contacts *C* and continues to do so as long as the button is pressed. The first contacts cut out steps of resistance in the generator-field circuit, and as the arm is gradually moved around by the little motor, the voltage rises and the motor speed increases. When the generator voltage is up to normal, the rheostat arm continues around, cutting resistance into the motor field, so that the speed of the motor continues to increase until the maximum is reached. The total number of steps is usually about one hundred.

When, however, the speed of the paper machine has reached any desired point, the pressure on the "fast" button is released, the little motor stops, and the paper machine continues to operate at that speed. On pressing the "stop" button, the machine stops; and on pressing the "start" button, the machine starts and is automatically accelerated to the speed as determined by the position of the rheostat arm. On pressing the "slow" button, the little rheostat motor moves backward, decreasing the speed of the machine as long as the pressure on the button is maintained. In this way the operator has the machine under complete control and can handle it with perfect ease.

Where a paper machine is engaged for long periods in turning out one kind of stock, full-automatic speed control is not needed and a somewhat simpler system, Fig. 5, can be used. In this system the push-button stations have only "start" and "stop" buttons, the speed of the machine being adjusted as need arises by turning by hand a rheostat handle on the controller *C* and *C* in the figure.

The latest development in paper-machine drive is to drive the rolls with several motors instead of one. By this system each section of the variable-speed line of the paper machine is driven by an individual direct-current adjustable-speed motor connected to the shaft of its section by a reduction gear. This system not only simplifies the transmission of power to the rolls, but permits an extremely accurate control. An automatic speed regulator is employed, which controls the speed not only of the whole variable-speed line but of each motor also, so that different relative speeds can be obtained. So sensitive is this regulator that speed variations as small as one-tenth of one per cent are instantly detected and corrected automatically.

This system possesses a number of important advantages. It requires but 50 per cent of the power of the older drive; it makes possible a greatly increased speed of the paper machine, since the regulation is so accurate that there is no danger of breaking the paper as it passes from one section to the next; the cost of maintenance is reduced, owing to the elimination of belts, gears, clutches, etc.; and no basement is needed under the paper machine.

Motors for Coaters and Super-Calenders

Coating machines and winders should be driven by variable-speed motors, and alternating-current wound-rotor motors are satisfactory for this service. But if direct current is available, it is better to use direct-current motors with speed adjustment by field control. The preferred control for these motors is a push-button station for starting and stopping, with a manually operated speed rheostat on the control panel. One of the earliest forms of motor drive for supercalenders was to use a small constant-speed motor, with ample gear reduction, for the slow threading-in speed, and a large constant-speed motor for the running speed, clutches being used to change from one speed to the other. This method, of course, offered no special operating advantages over belt drive, so a variable-speed wound-rotor was soon substituted for the large constant-speed motor. The wound-rotor motor not only permits smooth acceleration from the low speed to running speed, thus reducing the time lost in repairing breaks, but also provides a speed range of from normal to about 50 per cent below normal, which makes it possible to run off a variety of stocks at economical speeds. The method has proved satisfactory and is in use in a number of mills. A controller can be provided that controls the two motors as one, allowing the operator to start, speed up, and slow down machine at will.

A modification of this method is the use of a single wound-rotor motor, for both the high and the low speeds. The low speed is obtained by driving through a large gear reduction, and the high speed by means of a smaller gear reduction, variations between the two being obtained by means of a drum controller. This is a simpler arrangement than the two-motor drive, but is not as efficient when the low speed is used for long periods of time.

Where a wider range of speeds is needed, a direct-current motor is used, as in Fig. 7. A very low speed, approximately one-half the motor's normal speed, is obtained by the use of armature control, and speeds ranging from normal to three times normal are obtained by field control. A drum controller can be used with this method, the very low speed being obtained on the first step and the various running speeds on the remaining steps, of which there are usually about twenty. Or, an automatic controller, with push-buttons, similar to the paper-machine controller, can be employed.

Prolonging the Life of Condenser Tubes

By Julian N. Walton

The problem of maintaining surface condensers leak-proof has been a source of continued trouble to the condenser operator. To provide for contraction and expansion of the tubes, the condenser manufacturers have always realized that it was necessary to employ a packing box at each end of the condenser tube. It has been common practice to pack the tubes with either corset lace, cotton wicking or the later-developed packing which employs a pressed fiber bushing.

In some of the small condenser units manufacturers have attempted to lessen packing troubles by designing a condenser in which the tubes are expanded into one head, stuffing-boxes and packing being employed at the other ends of the tubes to provide for expansion and contraction.

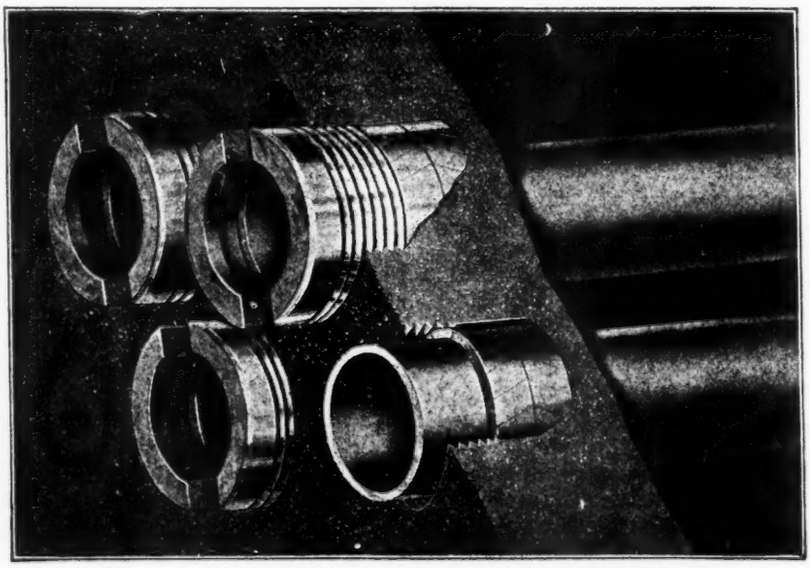


FIG. 1. RINGS INSTALLED WITH FERRULES IN PLACE

Surface-condenser efficiency is dependent upon high vacuum and high vacuum is dependent upon steam-tightness of the condenser tube packings. Today a 10,000- or 12,000-tube unit is not unusual. With units of this size or even smaller the length of tube necessary

to provide sufficient surface eliminates the possibility of adapting to the larger sizes of condenser the process of expanding the tubes into one tube sheet. This makes it necessary in the larger units to employ packing in both condenser ends.

Cotton wicking, corset lace and fiber rings have not given entire satisfaction in this service. These materials have but a temporary life and will eventually bake hard or rot out, causing leaky tubes. In many instances fiber bushings have swelled and baked to the tubes, holding them so rigid that sliding cannot occur with

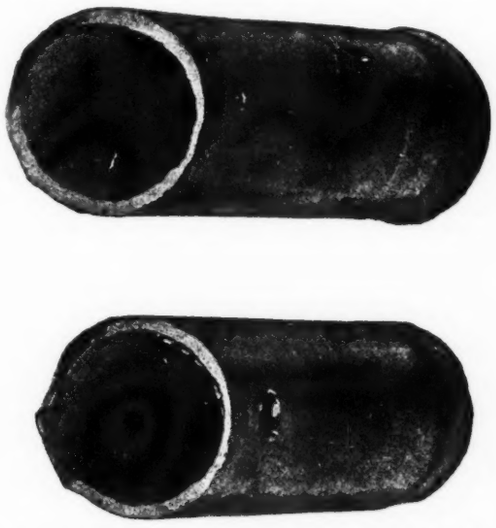


FIG. 2. SHOWING HOLES AND THIN SHELL OF TUBES

the temperature changes to which the tube is subjected, the result being that a tube so held is constantly subjected to tension and compression stresses which frequently cause buckling or cracking.

Of late years flexible metallic packing sets have been used to overcome these troublesome features. These sets are easily installed, there is no crushing of tube ends, and tubes so packed are free to move, owing to contraction and expansion with temperature changes. Being of metal composition, the rings should last as long as the shell of the condenser and are not readily affected by chemical action resulting from impure circulating water or from the addition of cleaning chemicals.

Fig. 1 shows the rings installed in the boxes of the condenser end with the ferrules in place. While the primary idea in using this expensive method was to develop a condenser packing that would be permanent and obviate troublesome features previously encountered, it develops that this process also has possibilities in prolonging condenser tube life.

Possibly a matter of even greater importance than that of packing maintenance in surface condensers has been the problem of the tube life. All condensers require brass or copper alloy tubes, and in many installations these tubes are subject to decomposition which is commonly attributed to either the improper alloy employed in the tube or to acid or alkali contained in the circulating water.

Many engineers have claimed that condenser-tube disintegration was a matter of galvanic or electrolytic action. Others have strongly opposed this theory, preferring to hold that the disintegration of the tubes was due to a metallic impurity or improper selection of materials entering into the condenser fabrication; and these engineers attribute all condenser-tube destruction to a process commonly termed by electrochemical engineers as that of "local action." Fig. 2 is a photographic reproduction showing disintegration of condenser tubes that had been in service but two years.

Present manufacturers of condenser tubes are using extreme care in the alloying of metal for tube production to the extent that the manufacturing of condenser tubes has become a chemical science, and it is logical to assume that the metals now used are of such an alloy as would offer the greatest resistance to the acid or alkalies that are so common in circulating water. But in spite of this, it is observed that the tube disintegration continues after the tubes are once placed in service in the condenser.

Disintegration Due to Electrolytic Action

Therefore it would seem that it is time to conclude that this tube disintegration is more a matter of electrolytic or galvanic action than it is of local action and that this process is due to electrolytic breaking down of the condenser-tube metals. The fabric packings have been largely responsible for this condition, for a condenser tube packed with an insulating material must be considered as an annode suspended in an electrolytic bath. The difference of potential that produces the current, which in turn destroys the metal, is produced by electrochemical differences of potential due to the dissimilarity of the metals, the tubes being of one composition, the shell of another, and in many instances the tube sheet of still a third metallic composition.

Reference to a table of electrochemical equivalents will indicate the difference of potential due to the dissimilarity of these metallic groups. While it is true that these metallic ingredients entering into the tube alloy are selected with a view to keeping it as near neutral as possible to the electrochemical equivalent of the shell, the fact remains that there is always enough difference to establish a difference of potential. Establishing this difference of potential results in the building up of minute currents which flow from the tube through the electrolyte or the impurities contained in the circulating water and thence to the tube sheet, and it is logical to assume that where a current leaves a condenser-tube surface through the medium of an electrolyte, the general laws of electrolytic action would apply.

Mettalic Packing Serves as Bond

Admitting that condenser-tube deterioration is due to this very process, it is easy to see that the metallic packing sets bond the condenser tube to the tube sheet, thereby offering a metallic path through which these currents may flow. There may then be present in the condenser this electrochemical difference of potential, but provision is made that the current so produced will flow through the tube rather than from the tube through the electrolyte.

Electrolytic action will be obviated, therefore, in the same manner that the destruction of water pipes is eliminated through the process of bonding. In other words, if the tubes are short-circuited, any currents flowing will be confined to metallic paths, and it is well-known that electrolytic decomposition of metal cannot occur unless an electric current leaves the metal through the medium of a suitable electrolyte.

Lubrication of Internal-Combustion Engines

By W. F. OSBORNE

Beginning with a discussion of the action of lubricants during each stroke, this article takes up in detail the various construction and operating conditions which affect the choice of oil for internal-combustion engines. A list of lubricating troubles is given, together with the causes of each.

WHEN a gas-engine man talks about lubrication, the first questions he asks are: Will the oil lubricate the cylinders? Will it provide proper piston seal? Will it form any carbon deposits? What will be the consumption?

There are so many types of internal-combustion engines, each having its own peculiar requirements, that it would be practically impossible to do justice to the entire subject within the scope of this article. We will therefore discuss only those types in which the power-plant engineer will be interested: Gas engines, gasoline and kerosene engines, fuel-oil and heavy-oil engines of the stationary types.

Considering first the lubrication of the power cylinder, the lubricating oil must do two things—lubricate the cylinder walls, piston and piston rings, and assist the piston rings to form a seal. As the greater proportion of power-plant engines operate on the four-stroke cycle, let us first investigate what happens to the oil on each of these four strokes.

Lubrication During Various Strokes

On the charging stroke the cylinder walls, as far as the piston travels, have been covered with a film of oil from the previous stroke, which, together with the oil on the piston and between the rings, acts as a lubricant for the piston and rings. The oil in the clearance space between the rings assists them in forming a seal to prevent leakage of air or vapor from the crank case into the cylinder. The air and vapor drawn into the cylinder is comparatively cool, and if the fuel is completely vaporized, there will be no detrimental effect on the film.

The film of oil left on the cylinder walls during the charging stroke, together with the new film picked up by the piston from the crank end of the cylinder walls, lubricates the piston on the compression stroke, and as the piston moves toward the cylinder head it smears a fresh film of oil on the walls. The supply of oil collecting on the advancing side of the piston rings and around the upper edge of the piston serves to prevent leakage of the gases being compressed. The degree of compression will depend, therefore, somewhat upon the seal-forming properties of the oil and on the condition of the cylinder, piston and rings.

During the compression stroke the temperature of the gases gradually increases, but does not rise high enough to do any damage to the oil film until near the end of the stroke, when most of the oil film is covered by the piston.

The film of oil placed on the cylinder walls by the piston on the compression stroke lubricates the piston on the explosion stroke. As the piston moves toward the crank, exposing the walls to the high temperature of the burning gases, the flame comes in contact with the oil film, but only after it has served its purpose of lubricating the piston on the in-stroke. The greater part of the damage to the oil film occurs on this stroke. The oil between the rings and between the piston and cylinder walls is subjected to the pressure of the burning gases and must assist the piston rings in preventing loss of power through leakage of the gases out of the open end of the cylinder.

If there is any trouble with lubrication, it will be encountered on the exhaust stroke, as the oil film on the cylinder walls has just been exposed to the high temperatures of the burning gases and has been more or less damaged. However, if the oil possesses the proper characteristics and has been applied in sufficient amount, some lubricating value remains, which, together with the oil film on the piston itself, lubricates the piston for this stroke.

Features Determining Kind of Oil to Use

Some of the features in the mechanical construction and the operating conditions of the engine, which determine the kind of oil that will satisfactorily meet the requirements previously mentioned, are: Cylinder temperatures, ignition, oiling systems, carburetion, cooling systems, revolutions per minute, fuel, piston clearances, atmospheric conditions.

Although it is a difficult matter to make accurate determinations of the actual temperatures within the cylinders, estimates made by various authorities are close enough for our purpose. The maximum temperature obtained immediately after firing is about 2,700 deg. F. and the minimum temperature during suction stroke, 250 deg. F. The average temperature for complete cycle is 950 deg. F. It should be remembered that these are temperatures of the gases and not the temperatures of the cylinder walls or of the oil film.

The inner surface of the cylinder wall probably ranges from 30 to 60 deg. F. hotter than the cooling water, depending on the thickness of the metal and the efficiency of the cooling system. As long as the water is not boiling, the cylinder-wall temperatures will hardly be more than 260-270 deg. F., and with a normal cooling-water temperature of 110 to 120 deg. F., at which many power-plant engines operate, the cylinder-wall temperature is below 175 deg. F. The oil film itself is hotter than this, at least on that side of the film exposed to the burning gases. The maximum temperature of 2,700 deg. F. occurs only when the piston moves toward the crank, uncovering the oil film and exposing it to the flame until near the end of the stroke. The inner surface of the oil film in contact with the cylinder wall at the comparatively low temperatures of 175-200 deg. F. is affected very little by the high temperatures, but the outer surface of the oil film directly exposed to the flame is undoubtedly damaged.

As it is impossible to produce a petroleum lubricating oil of any kind having a flash point over 700 deg. F., it would seem that the oil film exposed to an average temperature of 950 deg. F. would be destroyed promptly.

That such is not the case the engineer can readily prove to himself by pouring a few drops of oil on a red-hot plate. It will be several seconds before the oil is completely evaporated. If the engine is running 2,000 r.p.m., as automotive engines sometimes do, the oil film will be replaced twenty times a second; and even if the engine runs as slow as 30 r.p.m., a new oil film will be spread over the entire cylinder surface once every two seconds. So it is a comparatively simple matter to maintain the oil film if oils of suitable characteristics are used.

Influence of Completeness and Rapidity of Combustion on Selection of Lubricant

The completeness and the rapidity of combustion have a great influence on the kind of lubricant to be used and its life. If the fuel is delivered to the cylinder completely vaporized and thoroughly mixed with the correct amount of air, so that combustion is completed very soon after the beginning of the stroke, maximum temperatures are obtained when the piston completely covers the working surfaces of the cylinder, thus protecting the lubricating film from destruction. If the fuel is not completely vaporized and intimately mixed with air in the right proportions, it burns slowly, and as the piston uncovers the oil film, the burning fuel destroys it. An excessively lean mixture, through the presence of free oxygen, will allow the oil film to be completely burned up or at least so badly coked as to form carbon deposits. The bad effects of slow burning can be overcome sometimes by using a heavy-bodied oil.

Engines burning liquid fuels such as gasoline, kerosene or fuel oil, always have incomplete vaporization to contend with. When the liquid fuel enters the cylinder in the form of minute drops carried by the inrushing air or sprayed in through an injector, on striking the cylinder walls, some of the small particles adhere in a liquid form. The liquid fuel, having a solvent action on the lubrication oil, thins it down, frequently destroying the film. When a carburetor is used, a too rich mixture will cause some condensation of the fuel during the compression stroke, which also affects the oil film. This thinning down of the oil film may allow some of the oil to work up into the combustion space or be blown past the piston rings and out of the open end of the cylinder. You are all familiar with the drippage of fuel and oil from the open ends of the earlier types of kerosene-oil engines.

This leakage of fuel is a particularly serious matter for engines having inclosed crank-case oiling systems, because the dilution of the oil with the fuel soon thins it down to such an extent that it is no longer able to perform its duty of lubricating the bearings and cylinders or of providing a proper piston seal. Bearings many times are burned out when using a high-grade oil through no fault of the oil, but because of incomplete combustion of the fuel.

Incomplete Combustion Causes Carbon Deposits

Another trouble caused by incomplete combustion is carbon deposits. When carbon is formed, most engineers are inclined to place the blame on the oil. Imperfect combustion always results in the formation of carbon of some sort. Perhaps it will be nothing more serious than a smoky exhaust, but if the soot is caught by the excess of oil on the walls of the combustion space or on the valves, it soon becomes hardened and builds up rapidly with the addition of more oil and more soot. The lighter-bodied oils, which evaporate more quickly than the heavier oils, do not hold this soot so tenaciously. Consequently, when it is known that an engine has a tendency to smoke, it is highly advisable to use a light or medium-bodied oil. (The foregoing statement refers to black smoke caused by incomplete combustion. If the smoke is blue from burning oil, use a heavier oil).

Any method which the engine builder or the operating engineer can devise to improve the fuel combustion will at the same time improve the lubrication of the engine and increase the life of the oil, cylinder, piston and bearings.

Effect of Various Fuels

Natural gas, blast-furnace gas, producer gas and coke-oven gas, being comparatively slow-burning, do not produce high temperatures, but the heat generated is maintained over a considerable portion of the stroke, thus exposing the oil film to very severe conditions. Furthermore, these slow-burning gases are of necessity used in slow-speed engines because of the time required to complete the combustion, and a thicker oil film on the walls is necessary than for the higher-speed gasoline engines. Kerosene, being slower burning than gasoline, permitting of higher compression and requiring higher cylinder temperatures, imposes a severe service on the oil film, which must have exceptionally good lubricating qualities to stand up for any length of time. Fuel oils, too, are difficult to completely vaporize and have a pronounced tendency to smoke, although there are some designs of engines that have overcome this trouble to a certain extent. With the exception of the speed of combustion and the amount of noncombustible material carried into the cylinder by the fuel, the lubricating problem when using the various fuels becomes one of combustion. As the methods of carburetion and vaporization improve, there is no reason why the engines using fuel oil should be any harder to lubricate than those using the highest-test gasoline.

With ignition we have again the problem of combustion. If ignition takes place at exactly the proper time, resulting in the most complete combustion possible, maximum temperature will occur when the piston is very nearly on dead-center, and as the piston recedes, uncovering and exposing the film to the burning vapor, the temperature rapidly falls off. If the ignition is retarded, a slower and later burning occurs extending over a considerable portion of the stroke. This longer exposure of the oil film to the high temperature damages it and in fact may completely destroy it. Continuous retarded ignition quickly heats up the cylinder walls and the cooling water, thinning down the oil and frequently reducing its viscosity to the danger point.

The temperature of the cooling water influences the kind of oil to be selected when certain types of lubricating systems are used. A low temperature cools the cylinder walls and will sometimes prevent a heavy-bodied oil from spreading properly so that a portion of the cylinder may become dry. When experience with certain oils shows that this occurs, it can easily be remedied by using a lighter-bodied oil. Kerosene-oil engines, especially of the carburetor types, usually depend very largely upon the heat of compression to vaporize the fuel, and such engines are generally operated with very hot circulating water. In so far as the

higher temperature improves the fuel combustion, it will also lessen the strain on the oil film, and although it may thin down the film, the final result is much better than if the liquid fuel were allowed to wash the oil film away.

Importance of a Proper Seal

The operation of any internal-combustion engine is vitally affected by the degree of perfection of the seal of the piston within the cylinder. A practically perfect seal may be made by tight pistons or piston rings, but the improved compression and decreased leakage of gases is secured at the expense of greatly increased friction; in fact, the rings can be made so tight that the engine cannot be turned over at all.

A much more desirable form of seal can be secured and maintained by making use of the lubricating oil film necessarily existing for lubrication. As the piston advances, a quantity of oil builds up on the edge of the piston head and on the advancing side of the piston rings, which opposes the force of the compressed gases, so that if the oil is of sufficient body or viscosity to resist the force of the gases, a perfect seal is secured.

When the engine is cold, the clearances are much larger than when the engine is heated up to its running temperature. As good compression is of the greatest importance in starting a cold engine, the oil film can be of much assistance. Fortunately, petroleum oils have the characteristics of becoming thicker as the temperature is lowered, so that the oil film around the piston rings more satisfactorily resists the pressure within the cylinder.

Benefits of a Perfect Seal

A perfect seal maintained by lubricating oil secures many benefits:

1. Minimum lubricating oil consumption since a suitable oil, by maintaining a perfect seal, prevents the pressure of compression and explosion from wasting the oil or blowing it off the cylinder walls past the piston rings. It also prevents excessive quantities working into the cylinder from the suction stroke and being carried into the combustion space, where it is destroyed.

2. Minimum fuel consumption by preventing leaking of the fuel past the rings on compression and wasting of power on the firing stroke. A perfect seal does not allow excessive quantities of oil to work into the firing chamber, fouling spark plugs and interfering with the proper combustion of the fuel.

3. Minimum friction through the use of loose-fitting pistons and rings working on a lubricating film.

4. Reduced carbon deposits by cutting down the amount of oil working into the combustion space.

5. If a crank-case oiling system is provided, a perfect seal prevents the greater part of the hot gases from reaching the crank case, maintains lower oil temperatures and thus prevents excessive bearing and cooling-water temperatures.

6. In the operation of crank-case oiled engines a perfect seal reduces the amount of liquid fuel or vapors passing the rings and later condensing in the crank case, destroying the body of the oil. When the oil is thinned down by a mixture of liquid fuel, it is no longer able to maintain the piston seal at its original point and conditions rapidly become worse and worse.

In general we may say that when pistons and rings are tight we should use a light or medium-bodied oil; when they are loose or become worn, a heavier oil is necessary.

Oiling Systems

The method of supplying the oil to the piston and bearings affects the viscosity of the oils that can be used. The oil must always be thin enough to flow from the point of supply to the parts requiring lubrication. Heavier oils can be used with mechanical lubricators or pumps than when drip cups or splash systems are provided. With the inclosed crank-case oiling system we must always consider the possibility of fuel dilution, and any method that can be devised to continuously remove the fuel from the crank-case oil, thus maintaining its body, will be of great value in improving the efficiency of lubrication as well as the fuel economy.

Although some engine builders have carefully considered what lubricants will be most suitable for the parts of their engines requiring lubrication and then have designed their oiling systems accordingly, others have not. It would be a great benefit to the operating engineer if a larger number of the engine builders would give this phase of the subject more thought.

Contrary to the usual belief a high-speed engine is easier to lubricate than a slow-speed engine, because a new oil film can be placed on the cylinder walls more times per minute. If the oil is light enough to allow rapid spreading, this new film can be formed as fast as the old film is destroyed. The slower-speed engines allow more time for the oil film to be burned off, and a heavier-bodied oil is required. The lighter oils as a rule form less carbon than the heavier oils when used in the correct amounts, and on this account the engines using them are less likely to have trouble. When engines are located where they are exposed to low temperatures, it is necessary to have an oil with a pour test low enough for the oil to reach the parts requiring lubrication. If a splash system is used, a lower pour test is required than when a force-feed lubricator is used.

Some Lubrication Troubles

Now we come to some of the lubricating troubles: Dry cylinders, wet cylinders, carbon deposits, bearing troubles.

Dry cylinders may be caused by: (1) Oil burning off the cylinder; (2) too lean a fuel mixture; (3) too rich a fuel mixture; (4) imperfect carburetion; (5) late ignition; (6) dilution of oil in the crank case; (7) too hot circulating water; (8) too cold circulating water; (9) tight pistons or rings; (10) too heavy an oil; (11) too light an oil; (12) oil with too light a cold test; (13) not enough oil fed.

Wet cylinders, cylinder heads, valves and spark plugs may be caused by: (1) Two rich a fuel mixture; (2) imperfect carburetion; (3) failure of ignition; (4) dilution of oil in crank case; (5) excessive oil feed; (6) loose pistons or rings; (7) too thin an oil; (8) low temperature of cooling water and resulting lack of fuel vaporization.

Carbon deposits may be caused by: (1) Loose pistons or rings; (2) excessive oil feed; (3) too thin an oil; (4) too heavy an oil; (5) cold circulation water; (6) late ignition; (7) failure of ignition; (8) too lean a mixture; (9) too rich a mixture; (10) improperly vaporized fuel; (11) dirt and other noncombustible

material carried in with fuel or air; (12) improperly refined lubricating oil.

Worn out or burned out bearings, in inclosed crank-case engines: (1) Hot oil from leaking gases past piston; (2) oil too thin; (3) oil diluted by leakage of fuel from cylinders; (4) mechanical faults in bearings or bearing adjustments.

When any one of these things can happen to almost any engine, and as almost every engine may have one or more of these faults, it becomes a difficult matter to make any specific recommendations. We can make a general specification that will apply to the greater number of installations as follows: The oil should consist of highly refined and filtered pure mineral oils, having a cold test sufficiently low for the engine in question and of the correct viscosity.

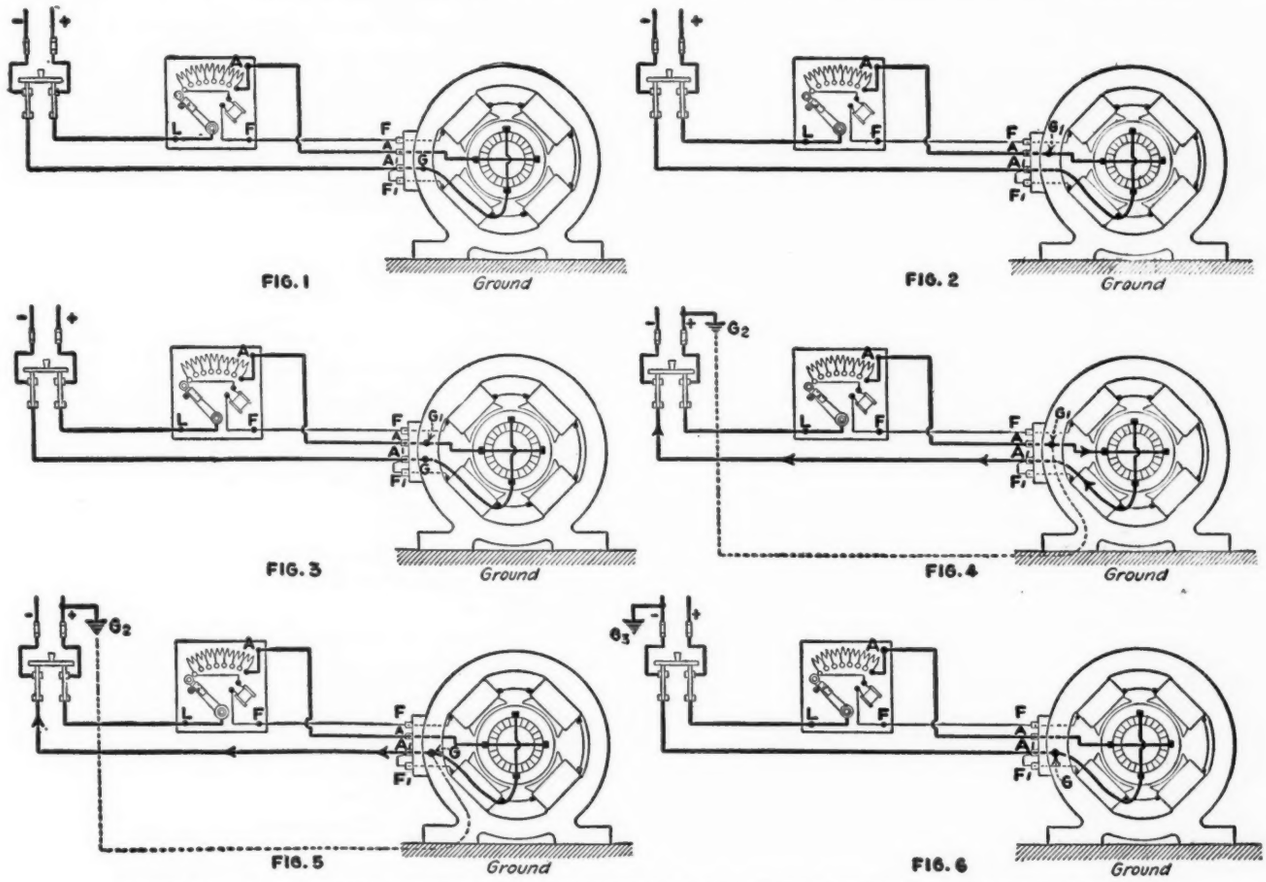
It will be noted that no mention is made of gravity, flash, fire or crudes. Suitable oils for internal-combustion engines are made from both asphaltic and paraffin crudes. The correct viscosity can be determined only by a careful examination of the engine and all the surrounding operating conditions. The most economical oil can be determined only by actual test under operating conditions. It is really up to the engine builder to find out and advise his customers what kind of oil to use.

Testing on a Grounded Circuit

BY E. C. PARHAM

WHETHER circuits be grounded by design, as are most direct-current railway circuits and many 110- to 220-volt three-wire circuits, or whether they be grounded by a fault, as may happen to any circuit which normally is insulated, precautions must be observed when applying a test-lamp circuit to the locating of fault grounds on such circuits. Otherwise, not only may testing results be absolutely false, but the tester may be subjected to flashes that may result in serious burns or in a dangerous fall. An experienced man is not likely to come to grief on a circuit that is purposely and permanently grounded, because the fact generally is well known; but he may get into trouble on a circuit that is supposed to be insulated but is not, if he is careless enough to treat the circuit as if it were clear rather than find out by test the conditions existing.

Fig. 1 gives the connections of a direct-current motor and starter on a circuit assumed to be clear of grounds.



FIGS. 1 TO 6. SHOWING DIFFERENT CONDITIONS OF GROUNDS OCCURRING ON MOTOR CIRCUITS

If the line is clear of grounds, a single ground on the motor circuit, as at G, will not affect the operation of the motor even if the frame of the machine was grounded. In fact, this would be the actual condition existing on a ground return system. Nor would a single ground, as at G_1, Fig. 2, affect operation, because the circuit being everywhere else clear of grounds, there

would be no ground path by means of which any part of the motor circuit could be bypassed. A ground at G and at G_1, Fig. 3, however, would bypass the motor-armature circuit, not only rendering it inoperative, but inviting destruction of the starter unless relief was promptly given by the blowing of a fuse. A line ground, at G_2, Fig. 4, for example, would not affect operation of the motor or of the starter unless one of these devices itself included a ground. A second ground at G_1, however, would bypass the starter, as indicated by the dotted line and arrowheads, and would blow the left-hand fuse immediately on closing the switch. A motor ground at G, Fig. 5, in addition to the line ground at G_2 would bypass the whole motor circuit, including the starter, and again would, on closing of the switch, cause the left-hand fuse to blow. It becomes manifest, then, that a motor ground is likely to cause trouble if a line ground exists, unless the motor ground and line ground are on the same side of the circuit as are G and G_3 in Fig. 6. Whether a ground interferes with the operation of the motor or not, it is a bad thing to have, because it invites other grounds and is a menace to the operator in that he will get a shock if he touches the ground and any contact having to do with the other side of the circuit.

To test for a grounded circuit, connect one end of the lamp circuit first to A, as in Fig. 7, then touch the other end of the lamp circuit to ground, next connect one terminal of the lamp to B and the other terminal to ground. If either connection causes the test lamps to light, it means that there is a line ground on the opposite side from the one that the lamp lights on and the lamp circuit connection that gives the light is the one to be used when testing. With a lamp in the test-lead from the ungrounded side of the test circuit, there will be no attending danger in touching either test lead anywhere. Suppose, for example, that it is desired to test for ground, an armature the motor frame of which is mounted on the structural iron part of a building and is therefore grounded. After determining the side of the circuit that the lamp lights on, as explained in Fig. 7, one of the lamp test leads is

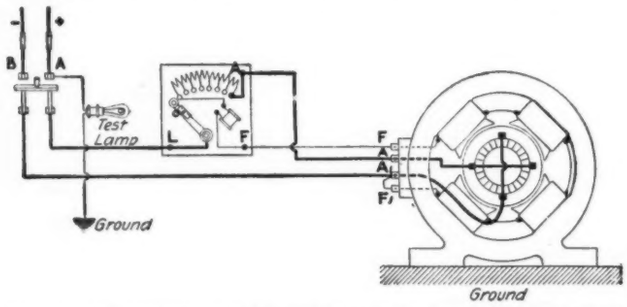


FIG. 7. METHOD OF LOCATING A GROUND ON ONE SIDE OF CIRCUIT

connected to this side of the circuit and the other is applied to the commutator after the brushes have been raised, as in Fig. 8. If it is desired to test the field coils for ground, the test lead that is applied to the commutator, Fig. 8, is applied to the field-coil terminals. To make sure that a return circuit will be provided in all cases, a lead can be brought from the grounded side of the line to the motor frame, as indicated by the dotted line Fig. 8. Where only one lead is used, this lead is touched first to the motor frame to make sure that the lamp will light, and then it is touched to the part the insulation of which is to be tested.

In the vernacular of the repair shop a ground means any irregular contact between the current-carrying part of a device and its metal containing case. Thus, if one of the coils of a starting rheostat sags down and touches the containing box, the coils and box will light

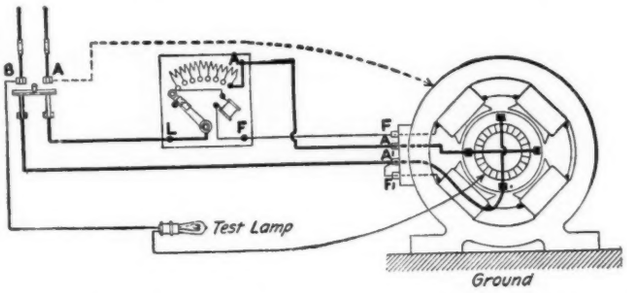


FIG. 8. CONNECTIONS FOR TESTING MOTOR'S ARMATURE FOR GROUNDS

out together and such a fault would be called a ground. This, however, would not be a ground to earth unless the box were so installed as to permit of the containing case actually making contact with the earth.

Safeguarding Pipe Lines Against Collapse

By John S. Carpenter*

Every hydraulic pipe line should be provided with a properly proportioned air vent to protect the pipe from collapse if a vacuum is created. In the case of a break the first thought is to shut off the water at the upper end and thus prevent further damage by the escaping torrent. In so doing, a vacuum will be formed in the pipe, owing to the fact that the discharging water excludes the atmosphere until the line is nearly empty, unless other means of access has been provided. Without such a vacuum breaker the pipe, if of any size at all, may collapse.

Some pipe lines have been designed to take the full atmospheric pressure without collapse, but this is very expensive in comparison with the cost of a properly designed air vent. Other engineers go still further and attach heavy air valves at frequent points along the line, especially at changes of grade. When there is no pressure in the pipe or if it is much below normal, these air valves open and admit air. A single air vent at the top of the line is usually sufficient unless the pipe is very large in diameter or the bends are sharp. These vents are seldom over eight feet long, and should be proportioned to supply air at such a rate that the difference between atmospheric pressure and that inside the pipe cannot exceed six pounds per square inch.

Let us assume that a pipe line has a break at its very bottom and that the regulating gates or sluices at the upper end have just been closed. The maximum velocity that would be possible for the water to acquire under frictionless conditions is

$$v = \sqrt{2gh} \qquad (1)$$

where

v = Velocity in feet per second;
g = Acceleration due to gravity = 32.16;
h = Total head on the pipe line in feet;

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and the water would discharge at the maximum rate of

$$Q = 0.7854\ D^2 \sqrt{2\ gh} = 6.3\ D^2\ h^{\frac{1}{2}} \qquad (2)$$

where

Q = Water discharged in cubic feet per second;
D = Diameter of the pipe in feet;

and the other symbols are as before.

It follows that air must be supplied at the same maximum rate, which, of course, includes a margin of safety; because the water will not quite acquire a velocity equal to the spouting velocity owing to the friction. From "Marks' Handbook" (first edition, p. 360, case 2) I take the formula for the flow of air through pipes, the drop in pressure being considerable:

$$d_1 = 1.294 \left(\frac{c\ Q_1^2\ L}{P_1^2 - P_2^2}\right)^{\frac{1}{5}} \qquad (3)$$

where d_1 is the diameter of the air vent in feet, L the length in feet, and $P_1 - P_2$ the drop in air pressure. The coefficient c is properly a variable quantity, but after taking six representative cases, it was found that without serious error it could be assumed constant with a value of 0.0000013. As already stated, the length is usually 8 ft. and the maximum drop in pressure 6 lb. per sq.in. Multiplying by 12 so that d is the diameter of the air vent in inches, equation (3) will now read

$$d = 1.294 \times 12 \left(\frac{0.0000013\ Q^2\ 8}{15^2 - 9^2}\right)^{\frac{1}{5}} \qquad (4)$$

which reduces to

$$d = 0.58\ Q_1^{\frac{2}{5}} \qquad (5)$$

Solving for Q_1 gives

$$Q_1 = 3.91\ d^{\frac{5}{2}} \qquad (6)$$

This is the volume of air at atmospheric pressure, and the volume at the pressure in the pipe will be

$$Q = Q_1 \times \frac{P_1}{P_2} = 3.91\ d^{\frac{5}{2}} \times \frac{15}{9} = 6.50\ d^{\frac{5}{2}} \qquad (7)$$

Equating this to the Q in equation (2) we have

$$6.50\ d^{\frac{5}{2}} = 6.3\ D^2 h^{\frac{1}{2}}$$

and finally

$$d^{\frac{5}{2}} = 0.97\ D^2 h^{\frac{1}{2}} \qquad (8)$$

When the conditions are such that a vent pipe larger than 10 in. is required, it is better to use one 10-in. vent at the top of the line and distribute the balance along the pipe line in the form of air valves, particularly at the changes in grade.

TABLE OF FIVE-HALVES POWERS FOR VARIOUS PIPE SIZES

Size	Power	Size	Power	Size	Power
3	16.50	5	53.50	9	242.0
3½	24.25	6	90.50	10	315.0
4	32.50	7	131.0	11	400.0
4½	43.00	8	185.0	12	500.0

Reports of the United States Bituminous-Coal Commission to the President

UNDER date of March 10, 1920, the majority of the commission appointed by the President to investigate the conditions in the bituminous-coal industry submitted a report containing recommendations and awards, and two days later the minority member submitted a dissenting report. This commission consisted of Henry M. Robinson, John P. White and Rembrandt Peale. The majority report was signed by Mr. Robinson, who was appointed as representing the public, and by Mr. Peale, as representing operators. The minority report was signed by Mr. White, as representing the mine workers.

The important features of the majority report provide for the elimination of the 14 per cent increase in wages fixed by the United States Fuel Administration, and instead of this an average increase of 27 per cent, which shall take effect April 1, 1920, and continue to and including March 31, 1922. The details of this average increase provide that an advance of 24c. per ton shall be paid for mining mine-run coal, but that day labor and monthly men be advanced $1 per day and that trappers and boys receiving less than men's wages be advanced 53c. per day; that the fulfillment of agreements shall be guaranteed by officers of the International Union as well as by the local officers of any district in which local agreements are made; that the eight-hour day in effect on Oct. 31, 1919, shall be written into agreements for which these earnings constitute a basis. Other points, such as that of pushing cars, the use of machinery in mines and charges for blacksmithing are dealt with, and provision is made for the creation of joint commissions to study local situations where the finding of a general commission such as this is obviously incomplete. In addition to the summary of awards the commission makes a number of specific recommendations to the public and to the miners and operators. The most important of these refer at some length to the methods of stablizing the coal industry throughout the year, to the methods of assigning cars to the various mines and to a general improvement of the conditions in mining communities, which are often under entire control of the operator.

In the body of the report considerable space is given to the question of the intermittency in working days in the coal-mining industry. Statistics from the United States Geological Survey are presented to show the extent of the intermittency, and the necessity for coöperation between the public, the operators and the railroads is emphasized. In arriving at the exact amount of increase in wages recommended, the report states that the following items were considered: The increase in the cost of living, the increase in wages received by workers in other industries and the effect of an increase in wages on the cost of producing coal. As to the probable distribution of the increase in wages toward the cost of coal to the public, the report says: "Whether all or any part of this amount will be passed on by the operators to the public depends on competitive conditions, but we estimate that the carrying out of other provisions of our findings will save the general public more than the cost of additional wages. It is to be expected that when all Government regulations are withdrawn and a competitive

market for coal is re-established, the overexpansion of the industry will not permit the operators to add to the price of the coal all the increased compensation granted to the miners." It is pointed out in another portion of the report that under a technicality in existing contracts the 14 per cent increase recently ordered by the Fuel Administration was in most cases passed on to the consumer.

A table is shown based on returns of 1,551 operators to the Bureau of Internal Revenue for the year 1918. Of this number about 22 per cent reported net losses and about 11 per cent reported incomes of less than 5 per cent on invested capital. An examination of the table, however, shows that these two classes of operators, while large in number, produce only about 11 per cent of the total tonnage represented in the returns tabulated. It is to be expected that companies that were not able to show a greater return than 5 per cent during the banner year of 1918 will discontinue operations under competitive conditions. Returning to the question of better stabilization of the coal-mining industry, the report expresses the opinion that the elimination of the winter peak and summer slump in demand would result in only those mines necessary to supply the steady year round demand being operated. Under these conditions the industry would not be compelled to support the excess equipment and the excess man power which is at present necessary to meet the uneven demand.

Regarding the question of voluntary absenteeism on the part of the miners it is pointed out that the figures submitted make no allowance for turn-over. In these tabulations every man who works in a mine at any time during the month is counted on the same basis as one who is on the roll every day that the mine was in operation. A man who works thirteen days out of a possible twenty-six in one mine and thirteen at another would be counted in these figures as two men with an aggregate voluntary absenteeism of twenty-six days, while, as a matter of fact, he has really worked an entire twenty-six day month. A further defect is that the number of days that a mine is in operation is not necessarily the number of days that the entire force have an opportunity of employment. Part of the mines may have been closed for various reasons, while other parts were working.

The demand for a six-hour day or a thirty-hour week was refused on the ground that such action would simply exaggerate the evils which it is hoped may be lessened by the efforts now being made to stabilize the industry.

The minority report submitted by Mr. White, while agreeing with the conclusion of the majority in a number of cases, differs in certain fundamental points. Even while agreeing with certain of the awards, Mr. White points out that the methods of arriving at these awards are not satisfactory from the miner's standpoint and are accepted only in the interest of honorable compromise.

Mr. White objects to the use of percentage increase where differential rates are allowed as in the case of pick-and-shovel mining as compared with machine mining. In such cases a percentage raise upsets the differential, which was based on a flat difference. He also advocates that all day labor and monthly men be advanced $1.35 per day and trappers and boys receiving less than men's wages be advanced 75c. per day instead of the figure awarded in the majority report. Furthermore, he objects to the idea of making increases correspond only to the increase in the cost of living. The last adjustment of the wage rate took place in November, 1917, and this barely brought the level of wages even with the cost of living. During the succeeding twenty-seven months the cost of living rose steadily.

Mr. White makes the claim that where the wages are adjusted only at long intervals, equity requires that they be raised enough in excess of the increase in the cost of living to cover this steady loss which goes on from month to month. Regarding the irregularity of employment and the demand for a thirty-hour week Mr. White points out that the thirty-hour week is actually about what the coal miner averages under present conditions. He asserts that the rates fixed by the majority report are based on a reasonable earning capacity of the miner and working forty-eight hours per week, which, however, the miner is unable to do owing in a large part to conditions beyond his control.

In other words, the miner is expected to work for forty-eight hours a week in order to earn a living wage, while at the same time he is prevented from working more than thirty hours per week. If labor is to be paid only on the basis of the actual hours which it must work to provide the requirements of the community, he maintains that it is unfair that capital should be paid for its continuous use if it is needed for only part of the time.

In regard to the reasons for the increases in the price of coal over pre-war prices, statistics are quoted from the Federal Trade Commission report on the coal industry. It is claimed that these figures establish the fact that the increased coal prices are not due to increased labor costs, but on the contrary are due largely to increased profits exacted by the operators, and that the increased wages to labor will be more than offset by the increased efficiency and the increased activity of labor.

Handling Hydraulic Governor During Short-Circuits

By L. W. Wyss

When a succession of transmission-line short-circuits interrupt the normal operation at hydro-electric plants, the oil pressure governors are opening and closing the turbine gates repeatedly in an endeavor to keep the speed normal. Under this condition the governor-oil pressure pumps may not be able to keep the governors supplied with oil under sufficient pressure to prevent excessive racing of the main units.

If there are spare govenor pumps, they should be used during such abnormal operation. The switchboard operator should also have his governors in mind at such times and not try out a short-circuited line often enough to cause a loss of governor pressure. Neither should he permit his station to remain connected to a line that is the source of enough severe short-circuits to cause the trouble mentioned. It is better operating practice to leave the line dead for a short time while the governors are regaining their pressure than to take chances of losing control of the turbine speed, which would perhaps result in a more lengthy interruption to service.

EDITORIALS

Agitation for Adoption of the Metric System

MANY readers have doubtless been deluged with circulars from the World Trade Club of San Francisco advocating adoption of the metric system of weights and measures in this country. This propaganda even went so far as an attempt to frame a bill in committee in Congress to make such adoption compulsory.

Accompanying the circulars are return postcards addressed to the Bureau of Standards and worded in the affirmative so that all the recipient has to do is to sign the card and drop it into the nearest mail box. He will then be counted among those unqualifiedly in favor of the metric system, and the number of cards received is counted upon to impress an unsuspecting Congress. Undoubtedly, many have deposited the cards without giving the subject much thought, basing their action solely upon the handiness of the decimal system. Few of those opposed will take the trouble to write letters voicing their opposition, and the cards do not provide for a negative expression of opinion.

Just what connection the Bureau of Standards has with the propaganda has not been revealed, but the World Trade Club of San Francisco, it has been established, is in no sense an organization such as the name would imply; instead, it is essentially a publicity bureau of a wealthy man now residing in California, who has made the metric system a hobby and who, it is understood, has to a large extent been financing the campaign.

The metric system has certain advantages and other disadvantages and, were industry starting anew, it might be desirable to adopt such a system in spite of slight disadvantages. But the real difficulty lies in the fact that there is no direct conversion between it and the system now in use, and it requires little imagination to picture the confusion that would result from its compulsory adoption. Not only would all existing drawings and patterns have to be revised or scrapped, but the workmen would have to be retrained in the use of the new system.

An incident pertinent to this may be cited. During the war the Ordnance Department adopted certain French designs and sizes and attempted to manufacture the material in this country according to the metric measurements. The results were disastrous, and finally all dimensions had to be converted into the English system. Even then, in the absence of a direct conversion factor, it meant working with very cumbersome figures instead of round numbers.

In countries where the metric system has long been in use as in France, where it has been compulsory since 1837, many of the old units still persist and are in daily use. Practice seems to have settled down to the use of those units that proved most convenient. The real danger, however, in the present propaganda lies in the fact that it emanates from an idealistic source with the apparent sanction of a body whose experience has been almost wholly along research and scientific lines; this in the face of practically unanimous opposition from the great body of American manufacturers who would be most affected by such a change. It is impracticable to legislate in such matters with any degree of success unless the demand comes from those directly concerned and after favorable sentiment has crystallized in those circles.

The Consumer Stands To Lose

A VERY brief outline of the United States Bituminous Coal Commission reports to the President is given in this issue. The fact that the commission was not unanimous is to be regretted, and a study of the reports suggests that the differences were due to the same old antagonism between the miners and operators, with very little regard to the final effect on the public.

The majority report puts considerable emphasis on the necessity of creating a more uniform market for coal throughout the year. If the country did not have to support a seven hundred million ton capacity to get five hundred million tons of coal a year, it is obvious that the public, the miner and the operator would all be better off. The report points out that a stable demand would result in the discontinuance of the less profitable mines, but this simply means that they would be opened again as the normal increase in demand required. Meanwhile, the public would be relieved from the burden of supporting the extra organizations necessary to take care of the winter peak load. Obviously, the remedy is in the hands of the consumer. If he will store coal in the slack months, this problem will be solved.

In granting increased rates to the miners, the majority report expresses an opinion that the operators will absorb this extra cost and pass little, if any, on to the public. In the same report it is noted that the fourteen per cent increase granted by the Fuel Administration was passed to the consumer by taking advantage of a technicality. With this in mind there seems to be very little hope of a twenty-seven per cent increase being absorbed anywhere but in the user's pocketbook.

The minority report lays great stress on the fact that the rates are based on a reasonable wage if the miner can work forty-eight hours a week, while in fact he only has a chance to work about thirty hours on an average. It argues, and the argument seems reasonable, that if capital is to be paid for continuous use, whether needed or not, labor should be paid on the same basis. Mr. White seems to have failed to note that neither capital nor labor can continue indefinitely to draw full-time pay for part-time work. If the present plans for stabilizing the industry are carried out (and they will be carried out), both mine and miner will have to work regularly and for a reasonable return.

The whole problem comes back to the summer storage of coal to relieve the excess winter demand. This will

eliminate the annual scramble which enables a few mines and dealers to boost prices, which keeps in operation twenty per cent more mine capacity than is needed and which breeds irregular employment, even when the demand is high because of temporary shortage of cars, of which there is a surplus for most of the year. It is probable that in the very near future the coal user, large or small, who makes no effort to store coal, will be looked upon as an enemy to the community. Meanwhile, the man who keeps ahead of his coal consumption by reasonable storage arrangements is getting a cheap form of insurance against shutdowns.

What Constitutes Proper Elevator Inspection?

AN elevator, either passenger or freight, in contradistinction to other means of transportation, moves in a vertical direction, consequently there is always a tendency for the car and counterweights to fall to the bottom of the hoistway with disastrous results. Yet with this handicap the modern passenger or freight elevator is the safest means of modern transportation. This high degree of reliability in operation has been attained by the development and installation of the proper safety devices, and in no method of transportation have safety devices been developed to so high a degree as in elevator service.

The modern elevator equipment is provided not only with means for automatically slowing the car down and stopping it at the top and bottom landings, but also with means of cutting the power off if, for any reason, the car travels past the terminals. In case the car overspeeds, it is automatically brought to a safe stop without injury to the passengers, as is also the case if the cable parts and the car is allowed to fall. With interlocks on the shaft doors and car gates the car cannot be started until both the doors and gates are properly closed. However, even with equipment correctly designed and installed, its functions can be easily defeated by the lack of adequate inspection and maintenance. Fortunately, most elevators are inspected at regular intervals by experienced men from some accident-insurance company. These men for the most part have become experts by virtue of their long experience in detecting defects in the equipment. But even these inspections, as thorough as they may be, do not entirely prevent elevator accidents, consequently wherever possible they should be supplemented by inspections by those who are directly in charge of the equipment.

How to make a proper inspection is something that can be learned only by experience and becoming familiar with the parts where failure is most likely to occur. In this issue is published a paper, "What Constitutes Proper Elevator Inspection?" by D. J. Gitto. Although this paper was written primarily for the guidance of insurance inspectors in their work, it is an excellent guide for the operating engineer and others who have elevators in their charge to follow in making regular inspections. It is difficult to overestimate the value of regular monthly inspections, or more frequent if conditions warrant, since, if properly made, defects are detected and may be repaired at the most convenient time before they cause shutdowns or serious accidents. What to look for and the procedure to follow is one very important factor in making these inspections. This Mr. Gitto explains in his article.

Low Salaries Force Men Out of Government Service

THE rate at which technically trained men are leaving the Government service because of inadequate compensation threatens to handicap very materially the work of many of the departments. During the war some of the bureaus accomplished results of far-reaching importance, and their personnel included men of recognized standing and ability. With the rising cost of living these men, whatever their personal inclinations, can no longer afford to remain in Government employ, and are accepting more lucrative offers from private concerns.

Congress, naturally, has reacted to popular demand for curtailment in expenditure, but in doing so has not in all cases given consideration to the relative importance of the various bureaus. Many new departments were created during the war, and existing departments enlarged the scope of their activities. Some of these have already been abolished; others are hanging on in an effort to justify their existence. However, Congress, apparently without careful study of the problem, so as to eliminate unnecessary Governmental activities and consolidate bureaus where duplication of work exists, has adopted the old system of wholesale pruning of appropriations.

As might be expected, it is the strong men that are leaving and the weaker men that are holding on. This is full of danger to industry in general as well as to the departments concerned, for in these days of increased Governmental control and supervision it is not only necessary to have men that can meet representatives of industry on an equal footing, but also quite essential that the Government's representatives be broad-gage men who can take a comprehensive and intelligent view of the problems coming before them.

Since a dollar invested in large steam-power plants makes available three or four times the power that a dollar invested in hydro-electric systems will, it has been suggested that it might be more to the nation's interest to concentrate upon improving our wasteful methods of utilizing coal than a development of our water powers. As far as can be foreseen our water power is inexhaustible, but at the present rate of consumption our coal supply will be exhausted at no distant future. Therefore, why not concentrate upon conserving our fuel supply by improving our wasteful methods of using it and by the development of our water power, even if the latter takes a few more dollars per horsepower? Every horsepower-year produced from waterfalls means five to fifty tons of coal that can remain in the mines for use at some future time.

Despite extended conferences, the conferees on the Water Power bill are making no progress in their efforts to adjust the differences between the Senate and the House on that important measure. The fear is being expressed that a considerable period will elapse before a compromise can be agreed upon. While few are of the belief that the bill will fail, several previous water-power bills have got only thus far.

The "free energy" fellows got all worked up over the aurora display the other evening. Boy, page Mr. Garabed.

CORRESPONDENCE

Distance of Bridge-Wall from Boiler Shell

In answer to A. L. Smythe, who in the issue of Feb. 24 asks about the proper distance of the bridge-wall from the boiler shell, I find that for an 80-in. boiler, as mentioned, the bridge-wall should be not more than ten or twelve inches from the boiler for good result. I have been in the game for many years and have found that a low bridge-wall will not allow of good combustion.

J. W. IRWIN.

Chicago, Ill.

Some months ago a new hand-operated stoker was installed under our boilers, and the plans furnished by the stoker concern called for a bridge-wall much lower than we had at that time. Whether due entirely to the stoker or partly to the lower wall, I am unable to say, but we have increased our capacity considerably and decreased our smoke since the installation.

I am of the opinion that the lower wall gives increased combustion space and also permits the flames to pass to the rear of the setting without coming in contact with the comparatively cool boiler surface; and as the tubes furnish the greater amount of surface for the absorption of heat, it seems reasonable that the large volume of hotter gas would evaporate more water.

I believe the majority of return-tubular boilers are set too low and chill the gas before proper combustion can take place.

HARRY H. YATES.

Trenton, N. J.

Regarding Mr. Smythe's difficulty with bridge-walls, and considering the dimensions of the boilers, it appears that the trouble is due to insufficient grate surface, as a boiler 78 in. in diameter and 19 ft. long should have a grate surface of approximately 49 sq.ft., figuring 55 sq.ft. of heating surface to one square foot of grate surface. Best results have been obtained in burning bituminous coal with an area over the bridge-wall about one-seventh the grate surface, which would give the distance twelve inches from the bridge-wall to the shell and not over fourteen inches. The other boiler mentioned would be about the same distance above the bridge-wall.

I would recommend a large combustion chamber in order to obtain better combustion when the fire is not crowded. This is also desirable under all conditions where the grate surface and the draft are adapted to the kind of coal that is being used. If it is desirable to burn a poorer grade of coal, on account of its low price, and the available draft pressure is insufficient to burn this coal at the required rate, the remedy is either to enlarge the grate surface or to use forced draft, or both.

Insufficient grate surface and poor coal, two causes of trouble, may be considered together, as they are correlated, and insufficient grate surface for one grade of coal may be ample for another grade.

I believe Mr. Smythe is right in his statements, and no doubt the conditions mentioned would give the results he is getting. I recommend that the grate surface be increased and that the bridge-wall be built not less than fourteen inches from the boiler shell.

St. Louis, Mo. R. GORDON.

A bridge-wall is thought by many engineers to be of great value in keeping the furnace flames against the boiler shell, thereby resulting in a saving of fuel. I have found some bridge-walls that come within six inches of the boiler shell and made to conform to the curvature of the shell, and also all sorts of elaborate designs that required considerable upkeep. A bridge-wall is for only one purpose and should be built to accomplish that purpose, which is to prevent fuel from being pushed off the grates into the combustion chamber back of the bridge-wall. A height of bridge-wall eight inches above the grates is sufficient to prevent this, and it should not be built higher when burning soft coal; even with hard coal a higher bridge-wall will be of no benefit.

A high bridge-wall forces the gas that is liberated from the burning coal, against the comparatively cold boiler shell, where it is cooled, and at this low temperature it passes along the boiler shell to the tubes and out through the tubes to the chimney without reaching a temperature sufficiently high to burn; consequently, these heat units are a total loss. These gases are brought into a combustible state by keeping them away from the cold boiler shell, so that more heat will be given up to making steam and a higher furnace efficiency obtained.

A high bridge-wall is not advisable, and if more coal is burned with a low bridge-wall, it is due to the fact that a high bridge-wall acted as a damper and retarded the flow of gases; a low bridge-wall does away with this choked passage.

I advise a bridge-wall with not less than an eight-inch space between it and the boiler shell. A damper should be placed in the stock and the draft regulated by it alone.

In case of excess boiler capacity I advise that an arch be built extending from one side wall to the other, the length depending on conditions. This can be done

if the boiler is not too close to the grates. An arch twenty-four inches deep with a six-foot span is a good one. Of course, about five inches of grate surface on each side will have to be removed to give room for the foundation of the arch, but in the case of excess boiler capacity, there is no doubt an excess of grate capacity, and this five-inch loss on each side will be of benefit.

Winkleman, Ariz. GEORGE J. TROSPER.

The main purpose of the bridge-wall is to prevent the fuel from dropping off the rear of the grates, into the combustion chamber. Incidentally, it tends to raise the temperature of the furnace, by providing a radiating surface; it also tends to throw the gas currents upward and along the bottom and sides of the boiler shell, and being an obstacle to the free flow of the gases it tends to promote a mixture of the gases and air, thereby improving combustion.

A rule commonly followed in proportioning the various gas passages is to make the area between the bridge-wall and boiler shell equal to one-seventh of the area of the grate surface, though some combustion engineers give one-sixth of the grate area as a proper proportion. The majority of them agree that for boilers' 72 in. in diameter the space between the top of the bridge-wall and boiler shell should be not less than fourteen inches.

Like many other rules, it is well to consider the special circumstances of the case before applying it. The first possible draft restriction between the furnace and the chimney is at the bridge-wall, and for burning bituminous coal, with the area between the top of the bridge-wall and boiler shell equal to one-sixth or one-seventh of the grate area, there should be no draft restriction at that point. If the space of fourteen inches is allowed, the draft area in a case of a 72-in. return-tubular boiler, between the top of the bridge-wall and boiler, will be approximately double the area of the boiler tubes, and in the case of a smaller boiler it would be considerable more; and as there would be no gas restriction at this point with this proportioning, it would prove a considerable advantage toward proper combustion. RICHARD PARROTT, JR.

Plainfield, N. J.

Increasing Trap Expansion Movement

A number of steam traps are still made which rely for their operation on the linear expansion of a metal tube or on the difference of expansion of two tubes of different metals.

Such steam traps generally suffer from considerable wiredrawing at the valve, because the movement of the valve from its seat is equal only to the linear expansion of the tube, and for small temperature differences and tubes of medium length the actual movement is very small.

To produce a greater movement by expansion for the same temperature differences, we might utilize a flat bar of metal of moderate length, say only 12 in. long, the bar being firmly held between two points, the distance from each other remains unalterable or nearly so. With an increase in temperature this bar will curve and its center *C* will be moved in a direction normal to its axis.

Assuming that the linear expansion of bronze for one degree C. is 0.0000177 per unit of length and that the change in temperature is 5 deg. C., then a bar 12 in. long will have after expansion a length of $12 + (0.0000177 \times 12 \times 5) = 12.001062$ in. and the total amount of movement produced by the free end would be 0.001062 in. If this bar is firmly held between two points, as at *A* and *B*, Fig. 1, whose distance apart is 12 in. and then expands the same amount, its center will move outward in a direction normal to its axis. The

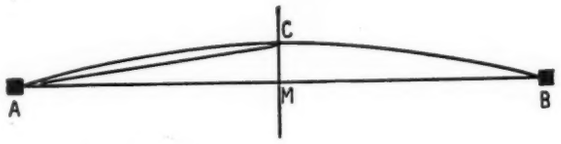


FIG. 1. REPRESENTING 12-IN. BAR HELD RIGIDLY AT ENDS, AND CURVATURE DUE TO EXPANSION

center line of the bar will assume a curvature. Assuming that this curve is a circular one, then the length of the arc = *A C B* will be 12.001062 in. and its chord = *A B* will be 12 in.

As $ACB = \frac{8AC - AB}{3}$, we get $AC = \frac{3 \times 12.001062 + 12}{8}$ = 6.0004 inch.

C M, or the amount of movement of the center of the bar $= \sqrt{(A\ C)^2 - (A\ M)^2} = \sqrt{36.0048 - 36} =$ 0.069 inch.

This movement is about 65 times as large as the movement resulting from linear expansion, which for

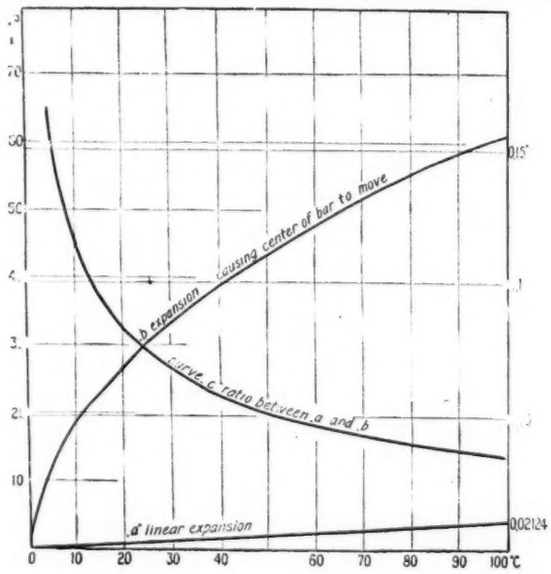


FIG. 2. CURVES FOR TEMPERATURE DIFFERENCES

the same length of bar and the same increase in temperature was found to be 0.001062 inch.

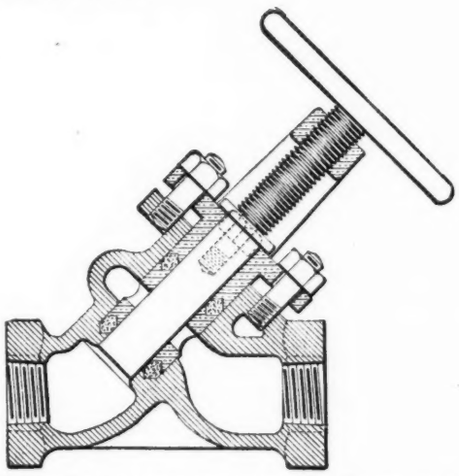
Plotting both movements for different temperature differences, Fig. 2, we get for the linear expansion a straight line and for the movement produced by the center of the bar, when its two ends are firmly held, a parabola. The larger the temperature difference the smaller will be the ratio of the two movements. Plotting on the same diagram the corresponding ratios, we get curve *C*.

As the temperature difference to which a bar in the service mentioned generally is exposed is small, the resulting movement might be multiplied to any desired degree by leverage, and without going to extremes a full opening of the valve may be realized at all times.

Half Way Tree, Jamaica, B. W. I. O. JANZEN.

Water-Column Blowoff Valves

Some time ago *Power* published a letter by Gustav Swenson which related to the subject of water-column blowoff valves. The problem of the water-column blowdown valve has been repeatedly presented to our engineering department, and we have been asked to develop a valve for this purpose and have evolved the valve shown in the sketch.



IMPROVED WATER-COLUMN BLOWOFF VALVE

In this little ¾-in. or 1-in. valve, which is made either in the straightway or angle pattern containing the seatless feature, the dirty water passes out through holes in the lower follower gland when the plunger, which is part of the stem, is raised into the open position by means of the handwheel. There is an annular space around the center follower ring so that the blowdown can freely pass out into the side or end port.

The valve is closed in the usual manner by means of the handwheel, which screws down the plunger until it passes the lower packing ring, when the flow ceases. The plunger continues down until the shoulder engages the upper follower ring, and then, as the operator gives one sharp final turn, the pressure is applied by means of this shoulder to the upper follower ring and through the upper packing and lower follower ring to the lower packing, so that the tighter the valve is closed the more the packing will be forced out against the plunger in its closed position and hence the tighter the valve.

The packing used is a vulcabeston molded ring. This type of small blowoff valve was first designed for the Stanley Motor Carriage Co., who have adopted it for use in conjunction with their steam automobile. They have found that it is the only blowoff valve that stays tight under their high-pressure steam conditions. The valve made for them has a ¼-in. pipe connection.

D. ROBERT YARNALL,
Philadelphia, Pa. Yarnall-Waring Co.

Starting the Oil To Run

Frequently, when my engine is to be started and I set the oil flow on the crank, instead of flowing in a stream it comes out of the cup in drops. My method of starting it to flow in a stream is to place my finger in the sight hole, letting the oil drop on the finger nail and then lift my finger until the oil begins to come in a stream. I then lower my finger, pulling it away quickly, and the oil will then run in a stream.

Woonsocket, R. I. CLEMENT COREY.

Alarm Clock Used To Open Oil Switch Automatically

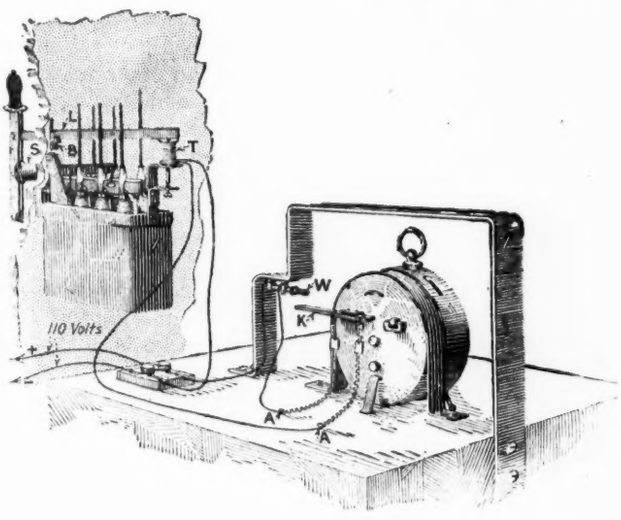
The following describes an arrangement that I have had in use in the power house for five years to turn out the street lights in a small town. The circuit was controlled by a hand-operated 2,300-volt oil switch, which was made automatic by the addition of an auxiliary lever, a spiral spring and by placing a steel catch block across the slot in the switchboard where the operating levels pass through, as indicated in the figure. When the switch is closed, the spring *S* is compressed and the slot in the lever *L* falls over the catch *B* and holds the switch closed.

In back of the switchboard, directly under the end of lever *L* and on the frame of the oil switch, is mounted a solenoid, *T*, with an iron plunger, so that when the coil is energized the iron plunger will lift the lever, thus releasing the switch.

On a common alarm clock I soldered an extension on the alarm winding key, with two small holes bored in it to attach the ends of two chains about ten inches long, as shown. In the end of each chain near the key is placed a piece of leather to insulate them from the clock. The chains and solenoid are connected in series with the 110-volt circuit. When the alarm goes off, the chains are twisted together, thus closing the circuit through the coil whose plunger trips the switch.

At first there were on the front of the board two contacts that opened, but another arrangement had to be devised, since sometimes the power was off when the time came for the clock to turn the lights out, and when the voltage was slowly built up the trip coil would not trip the switch.

This in a short time caused the coil to be burned out, so I made a frame for the clock and mounted a baby



CONNECTIONS OF ALARM CLOCK TO OIL SWITCH

knife-switch in back of it, as in the figure. To set the clock, which was done when the substation man came to put the lights on, it was slipped out of the frame and the alarm wound up by the key *K* and the chains hooked to contacts *A* and *A* and the switch *W* closed. When the clock goes off, it twists the chains together on the first half revolution and on the last half it opens the switch which cuts out the trip coil. E. LITTLEFIELD.

East St. Louis, Ill.

Keeping Out of the Rut

The letter of Thomas M. Gray, together with the editorial on the subject of "Keeping out of the Rut," as published in the Feb. 17 issue of POWER, brings out some excellent points for one to think over.

In dealing with the subject it is my belief that no engineer who is really 100 per cent interested will allow himself to slip into a very deep rut before he begins by concentrated effort to pull himself out and thus become a better man. I will exonerate the engineer for some of his shortcomings, which are justly chargeable to the management of the plant, for it is well known that many of the men holding the purse strings cannot see the economies which the engineer can make with proper coöperation from their side of the fence. This fact alone allows many a first-class engineer to get into so deep a rut that it takes the real man spirit in him to pull himself out. Is it any wonder, then that routine duties so often lead the engineer to make them in a careless manner because he feels that no one is interested enough to make a close check of his work? In many plants the man called "Chief" is not "Chief"; in reality he is the wet nurse to everything mechanical and electrical about the plant; his rut is a well-worn path from which he fears to tread.

The reasons for power-plant engineers becoming disinterested in their work are many, yet in the three cases cited in the following can be observed facts, not to be disputed, and in many plants the same conditions exist today, and the rut is well worn; whereas on the straight road there is plenty of room for all if they could but understand that it is the best and easiest way.

Take the case of three men employed as shift engineers in a moderate-sized plant, maintained in very good condition by the owners, although the human element side of the situation could be improved upon to the advantage of the management, as well as the men.

Jack works on the first trick and has general supervision over the forces employed on the other tricks, as well as making up the daily reports and looking after minor repairs about the station. Jack is in his thirties and works eight hours per day. He has had the benefit of several years in the boiler room as well as in the engineer's position, and he should be capable of handling the place well. Jack's trouble seems to be that he does not like the responsibilities of the position, nor will he study and read up on the modern ways of operation. His duties are performed in a mechanical sort of way, and when rendering discipline he is not there. Jack is surely in a rut and by concentrated effort could become a real engineer, yet he does not think it worth while to make the start. Some day he will find some other fellow in his job.

Pete is the second-trick engineer and receives his instructions from Jack. While on duty Pete is the boss, and yet he lacks enough initiative to do any more than the law compels for him to get by. Fortunately for him, he has been getting by for a long time at the expense of his employers. Some day he will wake up and will make a grand rush to get out of the rut, but he will find that the rut has swallowed him up. He simply holds on because Jack and John, the third-trick engineer, hold up his end for him.

John is the third-trick engineer and is a man about the age of Jack. He has had boiler-room training and is a real engineer in every way. He is interested in all things pertaining to the work and can be relied upon in case of emergency to do the right thing. He is out of the rut and is not going to get in very deep, for his time is too well occupied in educating himself for the better positions now being filled by someone in the rut. John can take the reports and explain why this or that happened and the remedy applied. He will, it is safe to say, not be a third-trick engineer very long.

It may be well to mention that in the plant from which this lesson is drawn the wages and the conditions in general are good, hence there is practically no excuse for Jack and Pete not to make good. The trouble is with the man and not the place in this case.

One manner of eliminating inefficient men is to have a national license law and grade the men according to their ability to pass a satisfactory examination, allowing sufficient points for practical experience and have the examination consist of practical problems. Proper classification of plants, etc., should also be given consideration.

PAUL R. DUFFEY.

Hagerstown, Ind.

National Engineers' Convention

Your editorial in the April 6 issue on "The Coming National Engineers' Convention" is on sound foundation. There is no difference of opinion as to the need of the engineer giving attention to his nontechnical interests and in a thoroughgoing manner. The question is, Through what instrumentality?

Several years ago the writer, as secretary of a local all-inclusive engineering society, backed a plan which provided that membership in an accredited local society should be a prerequisite to membership in the national. He felt strongly that the salvation of the profession so far as it would come through the development of organization depended upon the development of the local society. Since that time, through wider experience, he has found that the local developed up to a certain plane, a sort of dead level, where it stopped. It must have a proper state and national relation. The development of the home interest is of first importance, but will be dwarfed unless that development has, as a part of the process, national integration.

The proponents of a federation are in the position of those who advocated a confederation of states early in the history of the country. Before a nation came, the confederation had to be thrown overboard. A civil war was necessary later on to settle the question of integration of a nation as contrasted to state rights. The proponents of a federation are state-rights men. A strong all-inclusive organization will come about through integration. If a federation is formed, it will be but a step in the process of integration.

The American Association of Engineers has been offered as the integrating instrument in a letter addressed to the four national technical societies under date of Dec. 20, 1919. Whether eventually accepted or not, the principles on which A. A. E. are founded will prevail. The test of the National Convention to be held in Washington will be on its acceptance of broad principles, like the Constitutional Convention in 1787 which gave birth to the United States.

Chicago, Ill. C. E. DRAYER, SECRETARY,
American Association of Engineers.

Synchronous Motors for Driving Centrifugal Pumps

I was interested in reading the article on "Synchronous Motors for Driving Centrifugal Pumps," by Soren H. Mortensen, in the Jan. 20 issue of *Power*. On page 91, Fig. 4—"Starting Instructions"—according to these the motor is supposed to be brought up to approximately synchronous speed on the low-voltage tap, the field switch closed and the field circuit adjusted for normal field before the power switch is thrown from the starting to the running position. This would be an impossible method to use unless the pull-in load was comparatively small or the motor considerably underrated. My experience has been such that, except in special cases, I would never think of trying to have the motor pull the load into synchronism before full voltage is applied. One has only to witness the operation of a synchronous motor during starting and pull-in period on loads such as centrifugal pumps in order to realize how impossible the method quoted would be.

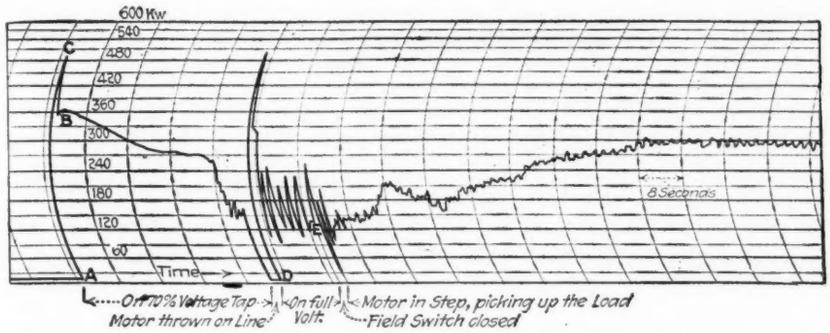


FIG. 1. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING AMMONIA COMPRESSOR

The key to Mr. Mortensen's statement, I believe, is found in the third paragraph of his article, where it says: "If the characteristics of the centrifugal pumps are such that, during the starting period, they require 70 to 80 per cent of full-load torque, it will be necessary to make the synchronous motor larger than would be the case if its capacity was limited through heating alone. For such cases over-excited synchronous motors for power correction are particularly suitable." I think 70 to 80 per cent is away too high, as I do not believe motors started according to the instructions given could pull in 30 per cent of normal load unless the motor was over-size.

A test curve showing starting and pull-in of a 2,200-volt three-phase 60 cycle 500 hp. 360 r.p.m. synchronous motor driving an ammonia compressor under more severe conditions than are ordinarily met with in centrifugal pumps is shown in Fig. 1. This curve reads from left to right. When the motor is first thrown on, the line kilovolt-amperes show approximately 360 at *B;* the initial peak at *C* is probably due to the over-swing of the needle. The kilovolt-amperes from this point decrease steadily for the next thirty seconds, indicating that the speed of the motor is increasing and the power factor becoming better. The power factor at starting will probably not exceed 30 to 40 per cent. The instant full voltage is thrown on at *D*, quite a large drag of current is taken from the line, although full allowance should be made for the over-throw swing of the needle. For about eight seconds the ammeter needle is swaying back and forth, indicating the rotor field increasing its speed and attempting to lock in with the stator field. At the point *E* where the field switch is closed, one big dip of the needle shows where a pole is slipping by and then the motor pulls into step and locks with the line. Immediately thereafter the valves are opened on the compressor and it begins to pick up load. The fluctuations of the line from there on are the reciprocating actions of the compressor cylinders. This particular compressor at pull-in requires a torque of 50 per cent of normal as near as we can judge. The motor, when carrying its full normal load, draws about 300 kw. from the line.

Now compare this with the curve as shown in Fig. 7 of Mr. Mortensen's article, reproduced here in Fig. 2. This is a peculiar looking curve, and I cannot understand why the excitation should be applied immediately the motor is started. It is very evident that such excitation is doing no good as the motor has not pulled into step, and some 30 seconds later full voltage is applied and the motor fluctuates along for about 30 seconds more before it pulls into step. I have never before seen a graphic curve of a synchronous motor at starting that looked at all like this. The speed, evidently, is not changed at all during the period the motor is running on part voltage, as the current fluctuations are of the same duration and that indicates the speed as remaining constant. Further discussion by Mr. Mortensen, or other readers of *Power* would no doubt be helpful on this subject, to which so much attention is being given at the present time.

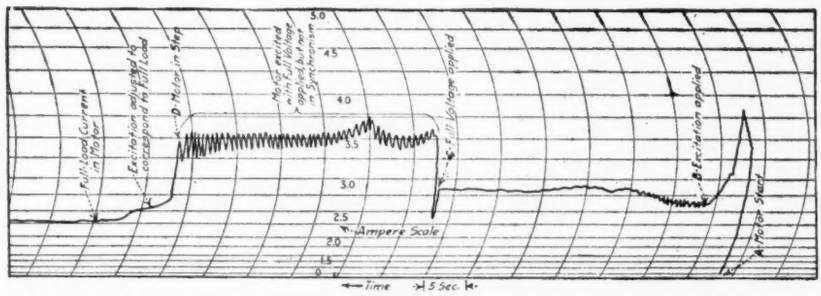


FIG. 2. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

B. S. STEVENS.

New York City.

Click in Corliss Engine

I was called on a few days ago to find the cause of clicking on an 800-hp. double-eccentric Corliss engine. I found three bolts in the rim of the flywheel loose. I removed them, heated them, drove them back into place. After tightening them, I started the engine and found that the trouble was overcome.

North Tonawanda, N. Y. C. J. MILLER.

Electric Arc Versus Gas Welds

On account of the rapidly advancing field of autogeneous welding in construction, maintenance and salvage work, the following results as shown by practical working tests may be of interest. These tests were performed by F. Hutton, M. E., a well-known welding expert, and myself. They covered a period of about two years, and afforded ample opportunity for a careful investigation of the subject from various standpoints.

The first class of work which I will here attempt to describe consisted of the repair by welding of defective B. & W. boiler steel headers, designed to withstand a working pressure of 225 lb. The welding required to repair the headers consisted of the filling in of worn lower corners and building up thinned 4-in.-tube seats to the original thickness with ample reinforcement to allow for machining. The saving effected by arc-welding these headers amounted to from 90 to 96 per cent of the original cost of new headers.

We obtained the best results with a direct-current, constant-potential machine with low voltage and a readily regulated heat control. A voltage not exceeding forty was used, and a metallic electrode giving a high tensile strength of weld and approximately 0.25 carbon and 0.7 manganese in the weld was found best for this class of work. After completing the welding and placing headers in the boring mill for machining the tube seats, it was found that the welded metal worked under the tool fully as well as the metal comprising the original header. In fact, any line of demarcation between weld and original metal was very hard indeed to locate by occular inspection.

We found, when inspecting the interior of these headers after over a year of continuous use under unfavorable working conditions, that the welded and built-up sections had in no way deteriorated. Much to the contrary was our experience with headers of the same type, physical, and chemical properties as those already mentioned, but which were welded by the oxyacetylene process. After being welded by this process, and when the machining of the tube seats was started, large sections of the weld tore or fell off under the tool, and in some cases the entire body of welded metal fell off, showing that no actual weld union had taken place, but only a sort of surface fusion or cementation which was easily loosened by contraction stresses and tool impact.

It is believed that in the first-mentioned case, where portions only came off, that the headers had received the required preheating necessary to insure a weld, but that the ensuing contraction stress caused cracks to develop in the weld and surrounding metal.

The second series of practical tests was in the salvage of pitted and broken ship propellers. The first repairs made in this class of work were by the oxyacetylene process and consisted in filling in pitted portions of blades and welding on special cast blade tips. The propeller blades having such a large area compared with their thickness, it was found that when the necessary preheating was done the blade had warped a considerable distance out of its original form. This meant, when the welding was completed, that an annealing treatment was required to restore the blade to its original contour and relieve contraction stress. This annealing was found to be only a partial remedy as the blade was not entirely restored to its original form, and without doubt a state of constant internal stress remained in the blade, tending to produce fracture when the usual working load was applied. Subsequent events seemed to prove this theory.

After the welded propellers were placed in service and subjected to the usual working stress, the blades broke off one at a time, and they all broke directly in the weld, the last blade on one propeller breaking off less than four months after the propeller was placed in service. This same class of work was performed on other like sets of propellers, but in this case the electric-arc process was employed. The same type of welding machine, voltage and equipment were used for this work as for the headers previously described. A softer metal electrode of less tensile strength was used in order to make the subsequent grinding and surfacing more easily done. The welding heat being well localized and under close control, no noticeable deformation of blade was produced; hence no annealing process was required, and the blades appeared to be free from any injurious internal stress.

After nearly twenty months' use, and being exposed to the same working conditions as mentioned in the case of the gas-welded propellers, an examination in dry dock was made. The welding and tips were found to be intact and in their original good condition except for a slight pitting, due no doubt to galvanic action. The saving effected by welding these propellers by the arc process amounted to from 70 to 78 per cent of their cost when new. On the other hand, in the case of the gas-welded propellers a considerable loss was incurred, due to the cost of dry docking, removal and replacing of propellers.

The results obtained on the two classes of work cited were repeated with various modifications on many other classes of work, and with various metals, including cast iron, cast steel, mild steel, nickel steel, bronze, monel metal and other alloys. In all classes it was found that the electric-arc weld was superior to the gas weld both in quality of work and in cost. I believe this to be due principally to the closely localized character of the heat generated by the electric arc, thereby minimizing heat deformation and contraction stress in the member being welded.

The distinct function of the oxyacetylene flame is for cutting, and in that field it is, I think, unexcelled.

I would invite a discussion on any lines pertaining to this subject.

CHARLES T. PERRY,
Mechanical Engineer,
New York City. Dept. of Plant and Structures.

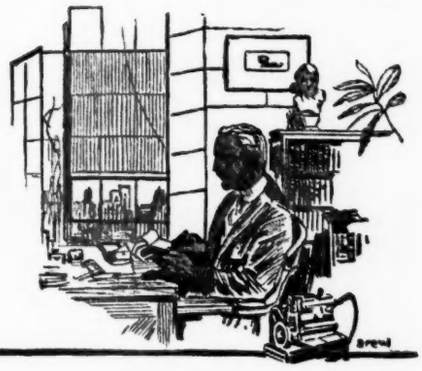
Continuous Use of Boiler Water

This is written with the intent of correcting a statement of Mr. Hill who, in the third paragraph of his article on page 320 of the March 2 issue, states that, "If there were no losses of water due to leakage, the same water could be used indefinitely."

I feel sure that Mr. Hill would not follow that practice, even if it were possible to do so, because he undoubtedly knows that water can become too pure for boiler purposes, and that if it is being used over and over without adding fresh water, the mineral properties which are necessary in a good boiler-feed water have been blown out through the blowoff pipes. Water in a pure state will attack the boiler metal and cause pitting.

H. W. ROSE.
Brenham, Tex.

INQUIRIES OF GENERAL INTEREST



Position of Exhaust Valves with Engine on Center—With a releasing valve gear, should the exhaust valve be open when the engine is on a center? H. S.

In a cut-off engine, the steam should be released from the cylinder by having the exhaust valve open before the end of the stroke, to insure prompt discharge of the steam and prevent undue back pressure during the return stroke. Consequently, when the engine is on a center and the piston has arrived at one end of its stroke, the exhaust valve on the other end of the cylinder would be open.

Increasing Size of Governor Driving Pulley—If a reduction is made in the diameter of a pulley on the main shaft of an engine for driving a flyball governor, what effect will it have on the speed? W. T.

Compared with the speed of the engine, the governor will be driven at relatively slower speed and the engine shaft will have to attain a higher speed before the speed of the governor is sufficient to check the supply of steam. Consequently, reducing the size of governor driving pulley on the mainshaft, or increasing the size of the governor receiving pulley, would cause the governor to regulate the engine at a higher speed.

Starting an Induction Motor—A 3-hp. 220-volt three-phase induction motor, driving a shaper, takes 60 amperes for about 20 seconds when first started. The current then drops to 5 amperes. Is this surge of current liable to harm the motor, and is the use of a starting compensator warranted? A. E. W.

A starting current of 60 amperes is not abnormal for the type of motor in question. And unless there is danger of the motor injuring the machine that it is starting, a starting compensator is not necessary. If you wish to properly protect the motor, you will have to do it by installing a double-throw switch with two sets of fuses—one set of about 15-ampere capacity on the running side, and another on the starting side of 30-ampere capacity.

Results of Belt Failures with Blocked Governors—With a blocked engine governor, what would happen if the main driving belt should break or if the governor belt broke or came off? W. D. T.

If the main belt should break, the load would be removed and the engine would race and perhaps be wrecked. With the governor belt broken or run off, the governor would supply the amount of steam corresponding to the blocked position, without power to increase the supply for an increase of the load or to decrease the supply for a decrease of the load, so that a load greater than that capable of being carried by the blocked position of the governor would cause the engine to slow down, but any less load would permit the engine to race and very likely to become wrecked.

Average Tangential Pressure on Crankpin—What is the average tangential pressure on the crankpin of a 14-in. x 20-in. engine where the m.e.p. is 40 lb.? C. B. H.

Neglecting the reduction of piston displacement from presence of the piston rod, the average total pressure acting on the piston would be $14 \times 14 \times 0.7854 \times 40 = 6157.6$ lb., and with 20-in. stroke the work performed per revolution would be $6157.6 \times 20 \times 2 = 246{,}304$ inch-pounds. Without allowance for loss from friction the same amount of work would be transmitted per revolution to the crankpin; and as in one revolution the length of path described by the crankpin center would be $20 \times 3.1416 = 62.832$ in., the average tangential pressure would be $246{,}304 \div 62.832 = 3{,}920$ lb.

Allowance for Strength of Girth Seams—In computing the strength required of girth joints of a horizontal return-tubular boiler shell, what allowance should be made for the reduction of area of the heads due to the tubes? W. L. C.

According to the **A. S. M. E. Boiler Code, par. 184, b:** "When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints." When less than 50 per cent of the solid head area is thus relieved, the strength of circumferential joints should be at least one-half the strength required for the longitudinal joints.

Power Factor in a Three-Phase Circuit—In a three-phase circuit the current is 30 deg. behind the electromotive force at 100 per cent power factor. Since the power factor is equal to the cosine of the phase angle between the current and voltage, what is the angle of lag in degrees at 90 per cent power factor in a three-phase circuit? E. C. H.

No doubt you have the current and voltage relations in the various parts of the circuit confused. The statement, "In a three-phase circuit the current is 30 deg. behind the voltage at 100 per cent power factor" is correct only regarding certain conditions, namely, the relation between the current in the current coil of a wattmeter, and the voltage applied to the potential coil and, where two wattmeters are connected in the circuit, the phase relation between the current in the current coil and the voltage in the potential coil is 30 deg. lagging in one instrument and 30 deg. leading in the other instrument. With a 90 per cent lagging power-factor load on the system the current in the load will be lagging approximately 26 deg. behind the voltage. At unity power factor in one of the meters the current and potential is 30 deg. out of step lagging. Therefore, in this instrument, with the load current lagging the voltage 26 deg., the difference of phase angle between the current in the current coil and that in the potential coil, will be $30 + 26 = 56$ deg., which represents a 56 per cent power factor. Bear in mind that this is only a mathematical condition, that the power factor is equal to the number of degrees in this case. In other meters at unity power factor the current in the current coil is leading the voltage applied to the potential coil by 30 deg., and when metering a load current that lags the voltage by 26 deg., the relation between the current in the current coil and the voltage in the potential coil will be $30 - 26 = 4$ deg. leading, which is equivalent to a power factor of 99.7 per cent.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Purchase of Coal on the B. T. U. Basis*

By A. L. LANGTRY

COAL is the basic fuel of the Nation. The war and the recent strike brought home to the public their utter helplessness without it. So far as the consumer is concerned, he is most vitally interested, for he pays, ultimately, all increases in wages, material, etc., that are connected with the production of coal. With prices advancing, the consumer is bound to give his purchases more attention than ever before.

Coal has been bought upon what is known as the "B.t.u. basis" for a number of years. Many a contract of this kind has been entered into in good faith by the consumer and seller, with the very best of intentions, but through the lack of fully understanding some of the details of the system, either one or the other has had a sad experience. Nine times out of ten when this method of purchasing has been condemned, the real fault has not been with the system itself. For instance, coal companies, instead of using an average analysis showing the quality of their coal as the basis of a contract, will use the analysis from a vein sample, thinking that this will represent what mine-run will analyze when received at destination. This is folly, for in the natural course of mining, in many mines, some of the roof comes down and the bottom up; it cannot be helped, for it is a physical impossibility to mine the coal and not have these impurities included. True, some of these impurities can be thrown out, but not all, and consequently those remaining increase the percentage of ash.

Very often the consumer makes his contract so drastic that it ceases to be equitable. He does not gather samples in a representative manner; the analyses are not correctly made, etc.

Purchase on the B.T.U. Basis Practical and Feasible

It is the author's belief that purchasing coal upon the B.t.u. basis is practical and feasible. To his knowledge it has been a success in some plants, working to the entire satisfaction of both seller and purchaser. This satisfactory condition has been brought about by the use of common sense, by exercising a little energy and by putting into practice well-known methods of good boiler-room practice.

Take, for example, a typical plant—one that is either hand or mechanically fired—a plant, for instance, that has never kept records of coal, water, efficiency or capacity of boilers. The advance in the price of coal in this plant has caused the chief engineer and manager to consider more carefully the purchase of coal for the ensuing year. Assume that the coal being used in this plant is apparently satisfactory, but the chief engineer and manager are not satisfied. They want some real information about the plant and coal, and decide to employ a specialist in making analysis and collecting representative samples of coal.

It is found that the quality of the coal delivered to the plant has the following average analysis: Moisture, 11.5; dry ash, 14.78; dry B.t.u., 12,305; price, $4.95; net B.t.u. for 1c., 43,350. The next step is to run boiler tests in the plant of long enough duration to determine the cost of evaporating 1,000 lb. of water from and at 212 deg. F., using the present contract coal. This figure proves to be $0.38. With this information a cost figure is established that can be used as a basis for comparison in determining the most economical coal to purchase in the future. Assume that the coal contract in this plant expired March 31 and that these tests started about Feb. 1., giving two months to gather complete information about the performance of the plant and test other coals deemed advisable. The "machinery" is now set in operation for purchasing the year's supply of coal, this "machinery" consisting of the manager, chief engineer and a thoroughly responsible and reputable coal chemist and fuel engineer.

*Paper presented before the Minnesota Joint Engineering Board, Minneapolis, Feb. 20, 1920.

The proper procedure, then, is to ask for coal proposals. It should be stated to the prospective bidders that, in addition to the price per ton, an analysis of the coal is to be submitted that will be representative of what the coal will run day in and day out. The figures so submitted by the coal companies are tabulated, with the assistance of the fuel engineer, and reduced to a comparative figure known as the "net B.t.u. for one cent." The method of arriving at this figure from the accompanying analysis is as follows: Moisture, 9.50; dry ash, 12.50; dry B.t.u., 12,650; price per ton, $5; net B.t.u. for 1c., 45,228. The B.t.u. in the dry coal multiplied by (100 per cent less the moisture in the coal) equals the B.t.u. in the coal as received. Multiply the B.t.u. as received by 2,000 (pounds in ton). Divide this product by the price of the coal plus half of the dry ash in the coal expressed as cents. The result is the net B.t.u. for one cent.

The fuel engineer should be able to advise with his client as to whether the analysis of the coal as submitted really represented what is actually produced. Coal companies often quote an analysis that does not truly represent the quality of their coal, and when this happens it is policy to confer with them regarding such discrepancies before even ordering coal for test purposes. In this way a complete and definite understanding may be had before negotiations are far under way. This is the nucleus for the successful operation of the B.t.u. contract in many cases.

Getting back again to the coal proposals submitted for this plant, they are given in Table I.

TABLE I. TABULATION OF COAL BIDS

Coal	Moisture, Per Cent	Dry Ash, Per Cent	Dry B.t.u.	Price	Net B.t.u. for 1c
County No. 1—Screenings—No. A Seam					
No. 1	12.0	11.0	12,850	$4.80	46,582
No. 2	12.4	12.0	12,703	4.80	45,792
No. 3	12.0	13.5	12,460	4.75	45,516
County No. 2—Screenings—No. B Seam					
No. 1	7.00	13.50	12,600	$5.00	46,242
No. 2	9.30	15.50	12,273	4.90	44,724
No. 3	9.85	16.20	12,171	4.90	44,056
County No. 3—Screenings—No. C Seam					
No. 1	8.50	12.00	12,700	$5.00	45,934
No. 2	9.10	13.60	12,452	5.00	44,668
No. 3	10.00	14.00	12,371	4.95	44,362
County No. 4—Screenings—No. D Seam					
No. 1	9.50	12.50	12,635	$5.00	45,168
No. 2	9.90	13.50	12,485	4.95	44,834
No. 3	10.00	14.50	12,341	4.90	44,668

Assuming that the analyses given in the table truly represent the quality of coal that is mined by each one of the bidders, it would then be in order to purchase the kind of coal that will give the most heat for the money from its respective county and seam. The net B.t.u. for one cent is the comparative figure in this respect when comparing coals, and should be used as a guide in determining the best coal to try for test purposes.

Referring again to the analyses as tabulated, it is easy to see the net B.t.u. for one cent that coal No. 1 listed under each county gives the greatest amount of heat for the money. To give the coals from the different localities a fair trial, it would then be advisable to order, for test purposes, the coal that shows the greatest net B.t.u. for one cent.. There should be, say, five cars of each kind, depending upon the size of the plant, so that a separate evaporative test could be run upon each. In this way it would be easy to determine which coal produced the least cost of evaporating 1,000 lb. of water from and at 212 deg. While the test coal is being used at the plant, representative samples should be collected from each and every car. These samples should be analyzed so as to have complete information as to the quality of the coal actually delivered. From the tests so run and the quality of the coal

delivered, the analyses and costs in the plant given in Table II were obtained.

TABLE II. ANALYSES AND COSTS AT THE PLANT

Coal	Moisture, Per Cent	Dry Ash, Per Cent	Dry B.t.u.	Contract Price	Delivered Price	Cost of evap. 1000 Ft. of Water
			County No. 1			
No. 1.....	12.5	16.80	12,875	$4.80	$4.783	$0.320
			County No. 2			
No. 1.....	8.0	12.50	12,759	5.00	5.014	0.357
			County No. 3			
No. 1.....	8.0	13.00	12,550	5.00	4.962	0.373
			County No. 4			
No. 1.....	10.50	13.50	12,480	5.00	4.878	0.397

The delivered value as shown is the result of a comparison between the coal actually delivered and that bid upon in the proposal submitted, according to the following rules:

B.t.u. dry in the coal multiplied by (100 per cent less the moisture in the coal) equals B t.u. as received. Multiply the B.t.u. as received by 2,000 and divide into the product the net B.t.u. for one cent on the coal bid upon. From the quotient subtract one-half of the percentage of ash in the dry coal, expressed as cents.

From Table II it will be seen that coal No. 1 from No. 1 County gave the least cost for making steam in the plant. It would be good practice for this plant, before signing the contract, to order ten cars or perhaps twenty. Samples should be gathered from the coal so delivered, making enough analyses to be certain of obtaining a good average as to the exact quality of the coal. Assume that this plan was carried out and that the analyses showed as in Table III.

TABLE III. RESULTS OF ANALYSES ON TRIAL ORDER

	Moisture	Dry Ash	Dry B.t.u.
4 cars.....	12.50	12.00	12,715
4 cars.....	11.95	11.50	12,796
4 cars.....	13.00	12.20	12,699
4 cars.....	11.41	10.95	12,871
Average.....	12.21	11.66	12,770

The average analysis in Table III compares favorably with the figures that were submitted originally by the coal company along with the bid, and is one that could be incorporated in the B.t.u. contract. Sometimes, in order to be absolutely certain of the basis of a contract, the first month's delivery of coal has been sampled and analyzed and the average of the analyses so made then used as the basis of the contract.

In addition to these precautions, contracts are drawn with a neutral zone, so to speak, of from 1 to 2 per cent leeway from net B.t.u. for one cent to allow for any slight variations or fluctuations that might occur in sampling the coal from time to time. This leeway has been found ample when a good average has been established on a coal.

The B.t.u. contract should include paragraphs pertaining to guaranteed analysis of coal, method of computing bonuses and penalties, a neutral zone before bonuses or penalties are paid, rejection of coal on account of quality or size, analyses for checking purposes, screen tests and standard methods in analyzing and sampling the coal. These items are in addition to the other necessary clauses of quantity, point of delivery, strikes, increase or decrease in miners' wages and freight rate per ton, etc.

Where a B.t.u. contract is in force, it means that the coal so delivered must be sampled regularly and analyses made from time to time. Samples are taken often from several different kinds of railroad equipment—the large 100 per cent self-clearing hopper cars, the eight-door hopper-bottom gondolas, the drop-bottom sixteen-door cars and the tight-bottom gondola cars. These are the types of cars that are in general use for coal.

Sampling can be done in several different ways—by hand, automatically and by use of a sampler device. It is advisable to gather separate and distinct samples from each car, this sample to be about 100 to 200 lb., the coal being thoroughly crushed, mixed and quartered until it is reduced to a pint or quart in size. The coal contractor should always have the privilege of having duplicat samples of his own to be analyzed for check purposes. To accomplish an equitable division of a sample, three containers should be filled—one to be analyzed by a non-interested chemist, the second to be delivered to the coal company and the third to be held for check purposes if necessary.

Summarizing, the application of the purchase of coal upon the B.t.u. basis would be as follows:

1. The purchase of coal upon the B.t.u. basis is a refinement of the "ordinary price per ton contract." It is simply adding to the price of the coal its quality for future identification.
2. Secure the proposals on coal, asking for a representative analysis of the coal.
3. Run evaporative tests on the best coal from its respective field or seam.
4. Use the cost of evaporating 1,000 lb. of water from and at 212 deg. F. as a guide in awarding a contract.
5. Order enough coal to demonstrate its adaptability to the plant conditions.
6. Sample and analyze all the coal deliveries so as to establish its grade or quality.
7. See that the sampling is in the hands of well-trained men who understand its importance.
8. The analyses must be made by chemists thoroughly experienced in coal work, using equipment of the highest possible standard.
9. Make the contract equitable.

What Constitutes Proper Elevator Inspection?*

By D. J. Gitto†

Elevators should be thoroughly inspected on every visit of the inspector. This means that no part should be passed because it was in apparent good condition at a previous inspection, but that a thorough inspection should be made of all parts, because a defect may have developed since the last inspection. Preparatory to performing the duties of an inspection, the inspector should properly begin with the elevator machine, in order to make sure that it is in a safe condition before exposing himself to the hazards so often resulting from riding on top of the car or performing the necessary inspection under it.

Brake leathers should be examined to see that they have not worn down to the rivets, for if the up or the down motion shoes, or both, should loosen the leathers, a serious accident would result, there being nothing to stop the elevator or check the counterweights in their course of travel. Make sure that the shoes properly grip the brake pulley. Inspect the worm screw and motor shafting to see that it is securely keyed to the coupling. Loose keys become worn and are liable to shear off. It is essential that all pin bolts have cotter pins in them, as these bolts are liable to work out. Examine the slack cable apron as to proper adjustment; also see that the slack cable collar is not cracked, that it engages the operating camwheel and that the slack cable apron pulls the switch, both operations setting the brakes.

Look over the bolts in the drum spider and make sure that they are all tight and that none are missing. Examine all the spokes of the winding drum for cracks and watch closely the secondary sheaves of traction elevators. Remove the oil cap on the gear housing to see the condition of the gear. See that the stop limits and the traveling limit nuts are in good condition. Try out both top and bottom limit stops before leaving the machine room; also see that the contacts are making properly so that no arc or flame is formed while running. Arcing at the contacts is liable to burn them together and make the limit cutouts of no use in stopping the elevator, resulting in the car hitting the overhead work or bumpers and causing damage to the

*This paper was presented before a meeting of the American Society of Safety Engineers, held in the Engineering Societies Building, March 19, 1920. Although written primarily as a guide to the proper procedure for making an insurance inspection of elevators, it is also an excellent guide for everyone who has to do with the inspection and maintenance of this type of equipment.—Editor.

†Inspector, Aetna Life Insurance Co.

machinery and perhaps loss of life. Watch for cracked arms in the operating camwheel on the machine.

Thoroughly examine the cables on the machine drum. Hoisting cables of overhead machines should be examined when the car is descending; do not rely entirely on feeling; have the car stopped at frequent intervals, and by the use of a small mirror you can better assure yourself of the condition of the cables. During the examination of the cables it is quite important that your hands should be kept clear of them in case the operator should reverse the motion of the machine. It is my opinion that too much care cannot be exercised at this point of an inspection.

Look over the vibrating sheaves, if any, to see that they vibrate freely and do not lag too much; also make sure that the main-line switches are properly fused and inclosed and that the operating control boards of overhead machines are equipped with pans to catch any arcing material that falls, thus avoiding possible fires.

Ride up in the car, trying every landing door, and see that the door locks and contacts, if any, are in proper working order. Examine car-operating control switch and see that the switch handle centers properly; then make a thorough inspection of the overhead work, looking for loose or worn shafts, missing or loose setscrews in sheaves, cracked sheaves, worn-out bushings of loose sheaves, good lead of cables to groove of sheaves and worn-out babbitt in bearing boxes. Examine the governor; try the tension of the spring to determine if it will readily act in case the car should drop or race; throw the clutch and see that it grips the cable properly. All parts should be oiled and grease provided where necessary.

Enter the shaft on top of the car at the top floor and, while riding down, carefully inspect all cables, cable sockets or thimbles. In examining the cables, do not rely on feeling while a car is in motion, but have the car stopped occasionally, so as to detect any place where the cables may have worn flat, in which case three-quarters of the strength of the cable has worn away. In such a condition these cables do not give any warning, but are quite likely to snap in case of a sudden strain. Do not overlook the cables where they enter the sockets, as this is one of the weakest points, if not properly attached. Watch for loose brackets and bolts. See that the rails are properly lined up, examine the governor cable socket clutch at the top of the car to ascertain if it would release when needed. Watch the wear of the guide shoes; try out the hatchway limits, top and bottom, as they sometimes become grounded, in which event they would be useless for any emergency. Look over counterweights for defects and chafed cables; see that tubing is provided for cables where they pass through the car counterweights; watch the wear of guide weights or shoes and see that the car and weights have proper clearance.

Examine the operating-cable device on the car for wear; see that the car gate is in proper working order; try out the safety device under the car and see that the jaws on both sides have equal and sufficient tension to do their required work. Experience has shown that this has often been the cause of the safety not holding when a car has fallen. At times only one jaw has set and, for lack of strength, has broken. This operation causes slackened car cables, and when the safety jaws let go, the cables are snapped and the car falls to the bottom of the hoistway with very serious and sometimes fatal results. Although it is not customary for inspectors to set the safety while a car is in motion, other than the testing after the installation, unless specifically called for, it is my opinion that every inspector should convince himself that the safety and all appliances are properly adjusted to act when necessary. Having tested out the appliances, the application of safeties can be done by hand from under the car—both instantaneous and friction-grip types. See that the governor cable on the drum is not jammed, as is so often the case. Examine compensating cable sheaves and tension weight at the bottom of the hoistway; make sure that they have not bottomed from stretched cables and see that electric cutouts are provided for the top of the frame to shut off the current in case a cable jumps off and jams. This would prevent the possibility of the sheaves and tension weight being carried up with the car, without the knowledge of the operator, and probably resulting in serious damage. See that necessary protection is taken by the installation of counterweight shield covers, overhead grating and inclosed machine rooms.

Hydraulic elevators generally require the same sort of inspection as already mentioned. They differ, however, in such particulars as pressure tanks, steam or electrically driven pumps, vertical and horizontal cylinders and plungers.

The pressure tanks should be watched for leaks, precaution being taken that the proper amount of water and air is carried, the standard being about three-quarters water and one-quarter air. Watch the operation of pumps and note if the regulating valves function properly for the pump to keep the required amount of water in the tank. Examine the operating cable lever in the car to see that it centers when the valve is closed; this, I would say, is very essential. Watch traveling sheaves closely as the bushings are inclined to wear; the sheaves in this case would have a tendency to lean, thus making slack cable which oftentimes jumps off.

Do not pass an elevator where the valve cups are leaking badly, as a serious accident might result from such an oversight. Great care should be taken while inspecting cables on vertical hydraulic elevators, especially where a series of cylinders are in a blind shaftway. Always keep yourself clear at all times and be prepared, in case the operator forgets himself and reverses the motion of the elevator. Learn to keep your hands well above or below where the cables come off the sheave. While inspecting this kind of a risk, do not allow the other elevators to be operated.

Always have your flashlight in good working order and carry it with you at all times. Do not use candles or strike matches in hoistways. Be sure of your operator; note his efficiency and give him implicit instructions as to how you want the car operated. It is my opinion that a car should never be operated and inspected by the same person. To be thoroughly and properly inspected, an operator should be provided.

Beating the Coal Famine

About 70 per cent of the power required to operate the Nordyke & Marmon Co. plant, Indianapolis, Ind., was produced during the coal famine of the strike by Marmon 34 automobile engines, Fordson tractors and Delco lighting systems. Thus the plant carried on and kept its thousands of people employed, says the *Boston News Bureau*. Thirty of the standard Marmon 34 engines drove electrical generators in the dynamometer room of the big plant all day long and produced about 1,000 hp. In other parts of the factory other Marmon 34 motors were directly connected to the line shafts and operated machine tools. Aside from this, more than a score of Fordson farm tractors were directly connected to the lineshafts in various parts of the plant and helped to produce power by gasoline, enabling the company to save more than the 50 per cent of coal-produced electrical current used in the plant. Delco lighting sets were distributed throughout the plant.

A report just issued by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C., shows exports of electrical machinery and appliances during the month of January, 1920. The value of battery exports totaled $374,730; carbons, $139,640; dynamos and generators, $413,293; electric fans, $29,587; insulated wire and cables, $661,842; meters and measuring instruments, $188,123; motors, $733,872; rheostats and controllers, $18,558; switches and accessories, $294,036; transformers, $350,364; and miscellaneous items amounted to $1,966,672. In general electric equipment Canada leads all other nations in its imports; China leads in the purchase of dynamos and generators; Japan comes first in the importation of motors which cost $213,924, while Norway leads in the purchase of transformers, costing $175,449.

Petroleum Production in the United States

Figures given in Table I, based on reports filed with the United States Geological Survey, show the quantity of oil received from producers. The production reported for California is estimated from figures and data collected by the Standard Oil Co. and the Independent Oil Producers' Agency.

TABLE I. PRODUCTION OF PETROLEUM IN THE UNITED STATES IN BARRELS

State	January, 1920 (a) Total	January, 1920 (a) Daily Average	January, 1918 Total	January, 1918 Daily Average
California	8,488,000	273,806	8,154,000	263,032
Oklahoma	7,958,000	256,710	8,049,000	259,645
Texas:				
Central and Northern	5,778,000	186,387	1,034,000	33,355
Coastal	1,441,000	46,484	1,695,000	54,677
Total Texas	7,219,000	232,871	2,729,000	88,032
Kansas	3,338,000	107,678	3,855,000	124,355
Louisiana:				
Northern	2,400,000	77,419	570,000	18,387
Coastal	167,000	5,387	211,000	6,806
Total Louisiana	2,567,000	82,806	781,000	25,194
Wyoming	1,171,000	37,774	840,000	27,097
Illinois	887,000	28,613	1,005,000	32,419
West Virginia	678,000	21,871	589,000	19,000
Pennsylvania	534,000	17,226	502,000	16,194
Ohio:				
Central and Southeastern	396,000	12,774	325,000	10,484
Lima	135,000	4,355	120,000	3,871
Total Ohio	531,000	17,129	445,000	14,355
Kentucky	475,000	15,323	265,000	8,548
Indiana	67,000	2,161	49,000	1,581
New York	56,000	1,806	49,000	1,581
Colorado	9,600	310	10,000	322
Tennessee	1,400	45	1,000	32
Montana	b	.....	7,000	226
Total	33,980,000	1,096,129	27,330,000	881,613

A record of imports and exports of mineral crude oil compiled by the Bureau of Foreign and Domestic Commerce is given in Table II.

TABLE II. REPORT OF U. S. IMPORTS AND EXPORTS OF MINERAL CRUDE OIL, IN BARRELS

	January, 1920	December, 1919	January, 1919
Imports:			
Mexico	6,293,353	4,330,576	3,899,376
Other countries	626	14,796	25
	6,293,979	4,345,372	3,899,401
Exports:			
Canada	421,618	868,673	270,553
Other countries	7,068	156,829	68,468
	428,686	1,025,502	339,021
Excess of imports over exports	5,865,293	3,319,870	3,560,380

The petroleum produced in Alaska is from a single patented claim in the Katalla oil field, according to the United States Geological Survey. The old wells on this claim and the refinery were operated as usual in 1918. Two new productive wells were also drilled in the Katalla field. The total production in 1918 was larger than in 1917. There has been a revival of interest in the potential Alaskan oil fields in anticipation of a law for the leasing of oil lands.

N. E. L. A. Convention

Important changes in the constitution and by-laws of the National Electric Light Association will be given a hearing at the convention in Pasadena next month. The proposed changes will enable the association to function for the greater benefit of all classes of members. For the first time in the history of the association, members of the state regulatory bodies will be given the privilege of addressing the convention.

Chairman Cail Jackson of the Wisconsin Railroad Commission will present a paper on "The Trend of Regulation" and E. O. Edgerton, chairman of the California Railroad Commission, will speak on "The Reward of Efficiency."

Explosion Hazard from Partly Consumed Coal Dust*

Where pulverized coal is used, large quantities of fine dust will accumulate on platforms, roof trusses, the outside of pipe lines, electric cables and even on the roofs of the buildings. The increased use of this fuel has led the Bureau of Mines to make investigations as to the liability of explosion from the resulting dust.

The Bureau of Mines collected samples of this so called "mill dust" and submitted them to chemical analyses, microscopic examination and flame and explosion tests. From the chemical analysis the volatile matter was found to range from 6.3 per cent to 23.54 per cent, fixed carbon from 50.88 to 67.08 per cent and ash from 22.29 to 32.16 per cent. Samples of the pure coal dust, before passing to the furnaces, were found to range in volatile matter from 30.50 to 36.81 per cent, fixed carbon 46.86 to 52.48 per cent and ash 9.26 to 21.84 per cent.

Under the microscope a sample of mill dust (which showed 23.5 per cent volatile matter by chemical analysis) was found to contain a large proportion of very fine partly coked coal dust, a small proportion of fine or medium fine partly coked coal dust and some dust thoroughly coked. From this and other examinations it would seem that some pulverized coal was being blown out of the combustion chambers before it had been thoroughly consumed.

Several samples were tested to compare the pressure that might be exerted by explosion of the dust with similar explosion of pure coal dust. In these tests about 0.003 oz. of the sample was blown over a heated coil in a glass globe and the pressure of the resulting explosion measured. Under these conditions pure coal dust gave a pressure of 14.5 lb. per sq.in., mill dust with 23.54 per cent volatile matter gave 10.21 lb. pressure, with 20.6 per cent volatile, 8.7 lb., and with 15.91 per cent volatile, 4.6 lb. per sq.in. Considering the small quantities of dust in these samples, it will be evident that large quantites would give much higher pressures, especially if confined.

Further explosion tests were made in the Bureau of Mines explosion gallery. Inflammability tests were made by dropping small clouds of dust into a clay roasting dish which had been heated to a temperature of about 2,000 deg. F. and also by blowing a small amount of dust over the flame of a Meker burner.

From all these tests it has been fairly well demonstrated that the line of division between mill dust which will explode and that which will not explode is reached when the dust contains about 11 per cent of volatile matter. Also, the higher the volatile matter the more violent will be the explosion, with the higher values not much below the pressures generated by a pure coal-dust explosion.

A fire that occurred several years ago illustrates some of the dangers of mill dust. A draft of air blew some of the dust over some red-hot iron, and the dust immediately took fire. The flames were communicated to the dust lying on roof trusses and spread so rapidly that the workmen in the mill barely escaped in safety.

Suggestions for safety from dust explosions include the following:

Fans driving the pulverized coal from storage bins to the furnaces should be run, after the fuel is shut off, until coal in the line is blown out. This is to avoid leaving smoldering sparks in the line from back draft. All places where dust might accumulate should be kept thoroughly cleaned and no open flames used while cleaning. All electric apparatus and wires should be kept clear of dust. Provision should be made to prevent static electric discharges in the pulverizing apparatus.

Manufacturers of Trenton who use fuel oil have been notified by the Standard Oil Co. that no more fuel oil will be shipped to Trenton after April 1 because of the great scarcity of the product. This will mean a loss to the manufacturers who use the oil and will result in considerable expense in changing back to coal burning.

*From the Bureau of Mines Monthly Report of Investigations.

Color Schemes for Plant Piping*

By H. L. Wilkinson

The importance of some definite and unmistakable means of readily distinguishing between the various pipe and conduit lines and systems in the power plant has long been recognized by both designing and operating engineers. Particularly in large power plants is this question of vital importance, and it should be stated that in some of the well-ordered large power plants reasonably satisfactory systems have been installed. Also there has been some effort made to standardize this practice, a committee appointed by the American Society of Mechanical Engineers to investigate the question having reported upon the preferable distinguishing colors for the various divisions of piping systems in the usual power plant. (See *Transactions* of the American Society of Mechanical Engineers, vol. 33, 1911, p. 17.)

Importance of Standardization Has Been Neglected

While the importance of standardization in this detail of our power plants has been recognized, too little attention has been given to the matter of late, and the writer believes that its importance should not be overlooked. It is therefore suggested that the members of this society consider the plan shown in the table and designed to apply to all piping systems.

It will be noted that the recommendation involves, in addition to piping lines, color schemes for machinery, motors, hand rails, dadoes, waste pails, elevator cages, etc., thus extending the usefulness of this distinguishing system to all parts of the industrial plant. It has been a revelation to the writer to find the cordial reception which this proposed color scheme has received in many industries and concerns of national prominence, and the result is that new industries and concerns are taking it up continually. The application of this standardization might well be extended to the designating by distinguishing colors the tools used in various departments of a plant. This would bring about several benefits. In the first place, it would enable managers to hold each department of a plant responsible for its own tools. Then, because of the improved appearance of the tools it would create more interest in their care on the part of mechanics. Last, and not least, it would surely be an insurance against tools being carried out of factories.

While this scheme designates definite colors for certain pipes, it is of course unnecessary to apply any one particular color on any one pipe, the arrangement being flexible so that an engineer may determine for himself his own design. In some cases, where there are as many as fifteen to twenty-five various pipe lines, it is necessary to use combination colors on some pipes, painting the straight pipe one color and the joints, valves, elbows, etc., the alternating color. Of course, some exceptions to personal selection will be found where an established custom has been in effect for some time, as in the case of sprinkler pipes and all fire lines, where vermillion is the logical color.

Illustrations of the Advantages of Standard Color Schemes

The advantage of this standardization will become readily apparent from the case of a certain plant where there was a stoppage or break in one of the pipe lines. The workmen carefully followed the line to the side wall where the trouble apparently existed and opened up the wall for a considerable area, only to be confronted with everything but the line they sought. Of course the expense of ripping out the wall was nothing compared to the inconvenience and loss sustained, due to the suspension of operation until this repair was made. If this pipe line had been painted with a distinguishing color and a small arrow placed on the wall where the pipe entered, indicating the direction the pipe took after entering the wall, all this difficulty would have been obviated.

Another condition that often arises is the leaking of a pipe on the third, fourth or some upper floor of a building. The engineers, usually on duty on the first floor or in the basement, would naturally be informed of the leak by the person discovering it, but without a doubt in the majority of cases the person reporting would be unable to tell the engineer which line of pipe was at fault, thus necessitating a journey from the basement to the floor in question. Furthermore, while it might be possible to shut off the pipe at a point convenient to the leak, probably it would be necessary for him to go back to the engine room and shut off the main valve. If, on the other hand, the individual discovering the leak could immediately telephone to the engineer that the blue, green, yellow, brown or black pipe was leaking, it would be possible at the main valve to instantly stop further leakage.

Another instance recently brought to the writer's attention is pertinent in showing vividly the value of standardization. One Sunday the watchman in a dye plant discovered that a pipe carrying a valuable liquid was leaking. The engineer was out of the city, which necessitated the watchman calling the manager. The manager was unfamiliar with the beginnings and endings of the maze of pipes, and it was only after considerable time that he was able to locate the proper valve to shut off. In the meantime considerable damage had been done, to say nothing of the loss of a large quantity of valuable acid. How easily the watchman could have stopped the leaking and prevented the damage if he had been guided immediately to the correct valve by following the color of the leaking pipe to the first valve of the same color.

Such a distinguishing system would appear to be indispensable in a plant with pipe lines carrying oil for automatic lubrication and acids for the treatment of goods in manufacture. A break in an acid pipe line, if not immediately shut off, may cause great damage.

A Color Scheme Will Result in All Pipes Being Protected by Paint

These simple illustrations have shown only one phase of the advantage of standardization. It will be readily recognized that the adoption of the standardization method in many plants will often carry with it the painting of pipes that heretofore have gone unprotected. Special paints are obtainable for these purposes, which possess the qualities of remaining uncracked under extremes of temperature, withstanding corrosion and affording superior protection against rust. An enamel paint is most suitable for general piping, but for power-house and other canvas-covered pipes a high-grade linseed-oil paint in white and colors should be used. The greatest benefits from the adoption of a method of standardization will accrue where careful thought is used in the selection of paints especially designed for this purpose. In cases where the surfaces to be painted are subject to unusually severe conditions of exposure to corrosion, a rust-preventive paint of established merit should be used for the first coat, followed with the standardization paint in the colors selected.

COLOR DESIGNATIONS FOR DIFFERENT CLASSES OF PIPING

Class of Piping	Color
Sprinkler pipes, fire pails, etc.	Vermilion
Compressed-air pipes	Dark gray
Oil pipes	Brown
Electric-light and power conduits	Black
Steam-power lines	Blue
Steam-exhaust lines	Buff
Hot-water pipes	Bright-red oxide
Cold-water pipes	Yellow
Motors and machinery	Bright green
Refrigerating lines	Maroon
Elevator cages, fire-doors, waste cans, railings, shelves, etc.	Bronze, green or black
Steam heating lines and radiators	Aluminum gray

*Abstract of a paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York, January, 1920.

In discussing the likelihood of steam turbines with outputs far in excess of current practice being installed in power stations of the future, I. V. Robinson says, in the *B. E. A. M. A. Journal*, that the chief limitation is that imposed by transport facilities, and suggests, as a remedy, that large machine tools should be installed in power-houses, so that the turbines could be partially constructed on the site.

Engineers' Influence in Public Utilities

On April 2 the Western Society of Engineers inaugurated a new society activity consisting of a series of monthly noonday luncheon meetings at which it is the plan to have short up-to-the-minute talks by prominent men on current topics of general public interest. The idea is to get the engineer away from the slide rule for a time and to give him an insight into big business and public affairs. The first meeting was a great success. Fully 600 attended. The speaker was Samuel Insull, president of the Commonwealth Edison Co., and the topic, "The Engineers' Influence in Public Utilities."

In his introductory remarks Mr. Insull referred to the need of exact knowledge on the public questions of the day. An engineer's training and his daily work are conducive to exact reasoning and logical, straight thinking. It is time that such men took their place in public affairs. The average politician is inclined to make the wildest claims imaginable, which seldom if ever approach the facts. If the engineer would apply his power of reasoning and present to his community the exact facts concerning the operation of public utilities, how different the impression that would be conveyed to the public mind.

Interests and Services of the Public Utilities No Longer Local

As far as the great public utilities were concerned, the average poltician and municipal officer, in seeking for power and patronage, insisted that their relation to the public was a question for home rule, when as a matter of fact the affairs of the utilities should be settled only on a state or interstate basis. Their interests and the services rendered were no longer local and the whole tendency was to make them less local. From the city, service has extended to outlying suburbs and half way across the state, and future power developments at the mines and waterfalls must of necessity be outside the city. In building up these institutions by combining and tying together numerous interests to effect economies in the service to the public, there had been nothing but criticism from the politicians and the public generally.

On subjects of this nature, primarily engineering in their character, the engineer should be a leader of thought. He should become posted on subjects that his specific training makes him capable of understanding and his next duty was to pass it along to the public, using his influence to protect the interests of the state in these great developments. The treatment and the general credit of the utilities were of far greater consequence to the community than to the owners themselves, as the latter generally have their eggs in more than one basket and the community has but one public utility in each class of service. Consequently, the prosperity of the utility, making development and extension possible, and the efficiency of service rendered, are matters of prime importance to the community. Incidentally, Mr. Insull gave some Chicago figures that were interesting. He said that with 2½ to 3 per cent of the population of the United States, Chicago central-station interests had produced 5 per cent of the total electrical energy distributed. From this, 6 per cent of the gross income of the public utilities of the country had been produced on an investment amounting to 3 per cent of the total capitalization. In other words, the Chicago company was doing business on 50 per cent less capital than the average throughout the United States. This was mainly the result of efficiency in sales engineering.

Possibilities and Advantages of Extension and Combination

To show the possibility in efficiency and conservation by extension and combination of public utilities, the speaker referred to the power survey of the Atlantic Coast section extending from Boston to Washington and sweeping in a semicircle 150 miles back from the coast, in which one-quarter of the entire generating capacity of the country is concentrated. By tying together the great transmission systems and supplying them with all available energy from water power and stations at the mouth of mines contiguous to this section, it had been estimated that a total capacity of 17,000,000 hp. could be replaced by 5,500,000 hp. The load factor would be increased from an average of 15 to 60 per cent, and half the coal formerly required (30,000,000 tons, worth $150,000,000) would be saved. In other operating expenses there could be saved another $150,000,000, making a total possible saving for the section of $300,000,000 per year.

It was the mission of the engineer to bring home to the public the possibilities and the great advantages of such a plan. With a saving of such magnitude in a small section of the country, it might be imagined what it would mean if the same principles were carried out throughout the entire country. Mr. Insull referred to the fact that if all the available water powers of the country were developed, they would not come anywhere near taking care of the power demand at the present time. As power-plant fuels, oil and natural gas were of minor importance, so that the future welfare of the country turned to the coal supply of this continent. The coal consumption of the country was already approaching 700,000,000 tons per year, with every prospect that it would increase by leaps and bounds, so that unless the greatest economy was obtained, future generations must suffer. The Atlantic Coast Survey gave an idea of what was possible in the way of coal conservation, and if the same plan were applied throughout the country, the saving would be enormous. It would take generations to accomplish, but could be immediately applied in sections where conditions were favorable.

With Government operation of utilities, lacking incentive and initiative, money would not be forthcoming for such great developments. In the interest of economy and conservation it was of the greatest importance, then, not to destroy the present value of these utilities and rob them by arbitrary action. Under such conditions it would be impossible for them to maintain their credit, to invest and stimulate development. Nothing would stop development more than interfering with transportation interests, and nothing would affect business interests more than mistreating the great local public utilities.

The engineer, then, should not confine himself to technical questions alone. He should become familiar with the facts and details of operation of the public utilities. By so doing he would comply with his duties as a citizen and contribute to the interests of the community and the country.

N.A.S.E. National Convention Committee

National President John J. Calahan has appointed Charles W. Bindrich, John A. Wickert and Thomas W. Armer as committeemen in charge of the coming national convention of the National Association of Stationary Engineers to be held in Milwaukee, Wis., Sept. 13 to 18. The executive committee is made up of the following: Program, Charles W. Bindrich, 562 W. 36th St., Milwaukee; publicity, John A. Wickert; halls and hotels, Thomas W. Armer, 133 Martin St., Milwaukee; reception, Henry J. Mustele; entertainment, J. A. Prudell; finance, Charles A. Cahill; transportation, Harry E. Fritz. Frank Cleveland, secretary of the convention bureau of the Milwaukee Chamber of Commerce, is chairman of the local exhibitors' committee. Headquarters will be in the Hotel Wisconsin. Thomas Green, Garlock Packing Co., Pittsburgh, Pa., is secretary of the National Exhibitors' Association.

Norway lacks coal, but it has an abundance of water-power. The power available for development in Norway is estimated at from 10,000,000 to 15,000,000 hp., and 1,300,000 hp. is now being used. In 1917 more than forty miles of the state railways had been electrified, and since that time the electrification of numerous short lines has been under way. Through the utilization of its enormous water-power in transportation and manufacturing—thus overcoming the handicap of a shortage of domestic coal—Norway, it is believed, will show marked industrial progress in the future.—*Pacific Power and Light Company's Bulletin.*

Waterwheels Used for Braking and Initial Power

An unusual use of waterwheels has been made at the plant of the Spanish Peak Lumber Co., Plumas County, Cal. Two 24-in. Pelton waterwheels, set in opposition, have been adapted to an aërial gravity tramway control to furnish power and braking effort as well as to drive a generator for lighting purposes, says the *Journal of Electricity*.

A braking effort to absorb a maximum excess of 12 hp. is necessary when the way is fully loaded, and a torque of 20 hp is required when the cable is not loaded. The two waterwheels are rigidly connected in opposition through a solid coupling, making up the driving and braking unit. They are controlled by needle nozzles, actuated by oil governors, in regulating the cable speed, the regulation being to hold the speed constant. The governors are so adjusted that when the cable slows down below normal speed, due to a light load, water is admitted to the driving motor and power is generated to hold the speed constant. When the cable is loaded and the speed tends to increase, the water is shut off the driving motor and is admitted to the braking motor. The impact of the buckets of the braking motor rotating against the jet develops the requisite braking effect and holds the speed normal.

Economy of Electric Drive

A comparison of performance of the motive power of the "New Mexico" with that of other battleships shows marked economy in favor of the electric drive. Thus, at twelve knots' speed the consumption in tons of oil per day was for the "New Mexico" (electric drive) 75 tons, as compared with the "Arizona" for her cruising turbines, 100 tons and main turbines, 118, and the "Mississippi" for her cruising turbines, 99 tons, and for her main turbines 115 tons of oil per day. At nineteen knots the consumption of the "New Mexico" was 263 tons, of the "Mississippi" main turbines 305 tons, and of the "Idaho" main turbines, 310 tons per day. Similar economy was shown by the electric drive at the intermediate speeds.—*Scientific American.*

New Publications

HYDRAULIC TURBINES. Third Edition. By R. L. Daugherty, A. B., M. E., Professor of Mechanical and Hydraulic Engineering, California Institute of Technology. Published by McGraw-Hill Book Co., Inc., New York. Cloth; 6 x 9 in.; 280 pages. Price, $3.

Originally intended as a brief outline of the general principle of hydraulic-turbine design, the present edition has been largely rewritten to conform to the changes in practice. The presentation of the theory has been considered and changes in its form made to make it more effective. It is realized that hydraulic-turbine design is a highly specialized industry, but the buyer and user of such machines should have some knowledge of their principles and characteristics. It is to furnish such needed information that the book was produced. The first part is given up to history, classification and description of hydraulic turbines, with a chapter on water as a source of power. The theory of turbines, methods of testing and turbine characteristics are given considerable space. A chapter on Selection of Type of Turbine and one on Costs of Turbines and Water Power should prove of especial interest to hydraulic power-plant men. The mathematical portions of the book assume a knowledge of trigonometry and calculus.

ARMATURE WINDING AND MOTOR REPAIR. By Daniel H. Braymer. Published by McGraw-Hill Book Co., Inc., New York, 1920. Cloth; 8 x 5½ in.; 515 pages; 298 illustrations. Price, $3.

This book is a collection of practical information and data covering winding and reconnecting procedure for direct and alternating-current machines, compiled for electrical men responsible for the operation and repair of motors and for the operation of generators in industrial plants and for repairmen and armature winders in electrical shops. No attempt has been made to discuss the subject of armature winding from the theoretical and design standpoints. Mathematics has been made use of in a very few cases, thus making the book easily read by those with a limited technical training. The book is divided into 17 chapters and an appendix: Direct-Current Windings; Alternating-Current Windings; Repair-Shop Methods for Rewinding Direct-Current Armatures; Making Connections to the Commutator; Testing Direct-Current Armature Windings; Operations Before and After Winding Direct-Current Armatures; Insulating Coils and Slots for Direct-Current and Alternating-Current Windings; Repair-Shop Methods for Rewinding Alternating-Current Machines; Testing Induction-Motor Windings for Mistakes and Faults; Adapting Direct-Current Motors to Changed Operating Conditions; Practical Ways for Reconnecting Induction Motors; Commutator Repairs; Adjusting Brushes and Correcting Brush Troubles; Inspection and Repair of Motor Starters, Motors and Generators; Diagnosis of Motor and Generator Troubles; Methods Used by Electrical Repairmen to Solve Special Troubles; Machine Equipment and Tools Needed in a Repair Shop; Appendix, Data and Reference Tables.

In all these the practical man has been kept in mind and the story of his problems is told in a clear and easily understood way. Although the number of subjects covered has made it necessary to limit the treatment of them to a considerable extent, those who have electrical repair problems to contend with will find much in this book that will assist them in the solution of these problems.

Obituary

Charles E. Barber, formerly of Watertown, N. Y., died at his home in Liverpool, March 22, at the age of 70 years. Mr. Barber, who was the brother of the late Henry A. Barber, the inventor of the Barber centrifugal pump, at one time manufactured and sold steam engines in Syracuse, N. Y. He was also the inventor of the Barber marine engine. He is survived by a widow, a brother, two sons, a daughter and two nephews.

Society Affairs

The National Association of Stationary Engineers, Texas State Association, will hold its annual convention at San Antonio, Texas, April 19-21.

The American Chemical Society will hold its spring meeting at St. Louis April 12-16. The general meeting and all divisional meetings will be held at the Hotel Statler.

The American Society of Mechanical Engineers, St. Louis Section, will hold a meeting April 30. H. F. Gauss, engineer, Illinois Stoker Co., will speak on "Development in Chain-Grate Stokers."

The Philadelphia Section of the A. S. M. E. will meet at the Engineering Club, Philadelphia, Pa., on April 27. Colonel W. P. Barba will discuss "The Modern Practice in the Manufacture of Steel."

The National Electric Light Association, Meter Committee, Technical and Hydro-Electric Section and the Ohio Electric Light Association, Columbus, Ohio, will hold a joint meeting at Columbus on April 22.

The American Society of Chemical Engineers, Eastern New York Section, will hold a meeting at the Edison Club, Schenectady, April 23. C. H. Bierbaum, consulting engineer will present a paper on "Bearing Metals."

The New York Section of the A. S. M. E. will meet at its headquarters, 33 West 39th St., April 13. The plans include the arrangement of a joint meeting with the Welding Societies. Subject, "Symposium on Welding."

National Electric Light Association—In a report by Harry M. Sessions, chairman of the Pacific Coast Section Membership Committee of the N. E. L. A., it was shown that more than two thousand new members have been added to the organization since last November.

The New Haven Branch, Connecticut Section of the A. S. M. E., will meet on April 16 at the Mason Laboratory of the Sheffield Scientific School. Arthur M. Greene, Jr., chairman of the research committee of the A. S. M. E. will present a paper entitled "Research."

The Detroit Engineering Society, Detroit, Mich., will hold its twenty-sixth annual banquet, Friday evening, April 23, at the Hotel Cadillac. Previous to the banquet a business meeting will be held at which the election of officers for the ensuing year will be announced.

Miscellaneous News

The Supreme Court recently dismissed the petition to rehear the appeal in the case of the North Carolina Public Service Co., and the Spencer Railway Co., vs. the Southern Power Co. The North Carolina Public Service Co. and the Spencer Railway Co. charge that discrimination was being shown by the Southern Power Co., in that they formerly furnished power to them at the rate of eleven mills per kilowatt, which they increased to eighteen mills, while it was furnishing its own subsidiary corporations power at the eleven-mill rate.

Business Items

The Roller-Smith Co., New York City, announces the appointment of Hammond D. Baker as manager of its branch office in Detroit.

The Pioneer Rubber Mills, of San Francisco, have sent D. D. Tripp, vice-president, on a trip to the Orient to observe the trade possibilities.

The Homestead Valve Manufacturing Co., Inc., of Homestead, Pa., announces the removal of its New York office to 242 Lafayette St., New York City.

The Niagara Falls Power Co., at its annual election of officers on March 26, elected Paul A. Schoellkorf, president, and Morris Cohn, Jr., John L. Harper and A. H. Schoellkorf, vice presidents.

The American Steam Conveyor Corp., Chicago, Ill., announces that the Kin-Wald Engineering Co., Mutual Life Building, Buffalo, N. Y., will act as its representative in Buffalo and western New York.

The American Sugar Refining Co. has awarded a contract for the construction of a sugar refinery at Baltimore, Md., to Stone & Webster. It is intended to begin work early in June. Estimated total cost, $10,000,000.

The Yarnall-Waring Co., manufacturers of power-plant devices in Philadelphia, Pa., has opened an office in Atlanta, Ga. D. T. Newman, formerly connected with the Philadelphia sales office, will assume charge of the new branch.

The Chicago Pneumatic Tool Co., announces the removal of its general offices from Chicago to New York City, where it will occupy a new ten-story building. The district sales branch of Chicago has moved to new quarters at 300 North Michigan Boulevard.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8 20@$8 65
Stove	8 45@ 9 05
Chestnut	8 55@ 9 05
Pea	7 05@ 7 40
Buckwheat	3 60@ 3 80
Rice	2 30@ 2 50
Barley	1 25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2 85@$3 35	$3 15@$3 60
F.o.b. Philadelphia, gross tons	5 05@ 5 60	5 35@ 5 90
F.o.b. New York, gross tons	5 40@ 5 95	5 75@ 6 25
Alongside Boston (water coal), gross tons	7 30@ 7 75	7 60@ 8 00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7 80@$8 25
Egg	8 20@ 8 65
Stove	8 45@ 9 05
Chestnut	8 55@ 9 05
Pea	7 05@ 7 40
Buckwheat	5 15
Rice	4 50
Barley	4 85
Boiler	4 85

Bituminous

Government prices at mines:	Spot
South Fork (best)	$3 25@$3 50
Cambria (best)	3 00@ 3 25
Cambria (ordinary)	2 60@ 2 90
Clearfield (best)	3 00@ 3 25
Clearfield (ordinary)	2 60@ 2 90
Reynoldsville	2 85@ 2 90
Quemahoning	3 25@ 3 50
Somerset (medium)	3 00@ 3 25
Somerset (poor)	2 50@ 2 75
Western Maryland	2 50@ 2 75
Fairmont	2 25@ 2 50
Latrobe	2 60@ 2 90
Greensburg	2 75@ 3 00
Westmoreland ¾ in	3 40@ 3 50
Westmoreland run-of-mine	2 75@ 3 00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.35, at the mines.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8 55	$10.80
Egg	8 80	10.65
Stove	9 00	10.85
Chestnut	9 10	10.85
Pea	7 75	9.30
Buckwheat	5 70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine-run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12 40@ 12 60

Pocahontas

Nine-run	$7.50

Domestic Bituminous

West Virginia split	$8.50
No. 8 Pittsburgh	$6 60@ 6.90
Massillon lump	8 25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5 25@$5.50
No. 8 slack	5 10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in	5 70@ 6.60
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, f. o. b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau, Will
Lump	$2.55@$2 70	$2 95@$3.10	$3 25@$3.40
Washed	2 75@ 2.90		3.45@ 3.60
Mine-run	2 35@ 2.50	2 75@ 2.90	3 00@ 3.15
Screen'gs	2.05@ 2 20	2 35@ 2.50	2 75@ 2.90

New Construction

PROPOSED WORK

Mass., Cambridge—The Barnard Constr. Co., 1783 Massachusetts Ave., will change the 5 story, 50 x 250 ft. dormitory building on Harvard St., into a hotel. A steam heating system will be installed in same. Work will be done by day labor.

Mass., Cambridge—The E. E. Gray Co. is having plans prepared for the construction of a 2 story, 140 x 230 ft. store house and refrigerating plant on Albany St. Total estimated cost, $250,000. F. F. Jonsberg Co., 16 Central St., Boston, archt. and engr.

N. Y., Addison—The Addison Electric Light & Power Co. is in the market for a 100 hp. heavy duty r.h. automatic belted steam engine and a 100 hp. high pressure return tubular steam boiler.

N. Y., Antwerp—The F. X. Baumert Co. is in the market for milk handling machinery, equipment and cold storage installation in its plant at Evans Mills.

N. Y., Attica—The Don Co. is in the market for one 100 lb. pressure 8 to 10 hp. vertical boiler.

N. Y., Buffalo—The city is having plans prepared by George H. Norton, City Engr., for installation of galvanized piping and the construction of an extension to the refrigeration system at the Washington market, here. Total estimated cost, $30,000.

N. Y., Gowanda—The Iroquois Utilities Corp., 39 West Main St., had plans prepared for the construction of a power house at Cattaragus Creek. Three 500 hp. generating units will be installed in same. Total estimated cost, $150,000. Charles E. Eaton, Sherman Bldg., Watertown, Consult. Engr.

N. Y., Hamburg—The Depew & Lancaster Light, Power & Conduit Co., Lancaster, plans to build an electric plant, here.

N. Y., New York—R. C. P. Boehler, Archt. and Engr., 38 West 32nd St., will soon award the contract for the construction of a 12 story loft building at 146 West 26th St. for the Leopold Realty Co. A steam heating system will be installed in same.

N. Y., New York—The New York Telephone Co., 15 Dey St., is having plans prepared for the construction of a telephone building on Vesey, Barclay and West Washington Sts. A steam heating system will be installed in same. Total estimated cost, $750,000. McKenzie, Voorhies & Grelin, 1123 B'way, Archts. and Engrs.

N. Y., New York—W. Whitehall, Archt. and Engr., 32 Union Sq., will soon award the contract for the construction of a 3 story, 45 x 75 ft. transformer station on East 6th St., for the New York Edison Co., Irving Pl. and 15th St. Estimated cost, $60,000. Noted Feb. 9.

N. J., Asbury Park—Froling & Holler, Archts. and Engrs., 150 Nassau St., New York City, are having plans for the construction of a 12 story hotel on Ocean Ave., between 2nd and 3rd Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Owner's name withheld.

N. J., East Orange—The city plans to build a community building. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. J., Irvington (Newark P. O.)—The Vreeland Motor Co., 407 Elizabeth Ave., Newark, will soon award the contract for the construction of a 1 and 2 story, 282 x 600 ft. factory, a 200 x 250 ft. office building and a 50 x 160 ft. machine shop on Cort St. A steam heating system will be installed in same. Total estimated cost, $300,000. John T. Simpson, Essex Bldg., Newark, Archt.

N. J., Jersey City—Francisco-Jacobus 511 5th Ave., New York City, engineers for the proposed power house, here, for the Continental Candy Co., are in the market for 2 generators, 3 boilers and two 200 kw. engines.

N. J., Newark—Jarvis Hunt, Archt., 30 North Michigan Ave., Chicago, will soon award the contract for the construction of a 25 story addition to the Department store on Market St., for the L. Bamberger & Co., Market St. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Pa., Harrisburg—The Water Dept. plans to construct a 25,000,000 to 30,000,000 gal. reservoir and install a 40 hp. boiler and pump, etc. at the pumping station, here. S. F. Hassler, Comr.

Pa., Marcus Hook — Ballinger Perrot, Archts. and Engrs., 329 South Broad St., will soon award the contract for the construction of a 3 story, 6 x 110 ft. boiler house for the Viscose Co. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Philadelphia—The Bd. Educ., Keystone Bldg., plans to rebuild 3 story school building on 7th and Norris Sts. A steam heating system will be installed in same. Total estimated cost, $400,000.

Pa., Philadelphia—The Bd. Educ., Keystone Bldg., plans to rebuild 3 story school building on 6th St. and Fairmount Ave. A steam heating system will be installed in same. Total estimated cost, $400,000.

Md., Baltimore—O. G. Simonson, Archt., will soon award the contract for the construction of a 3 story, 300 x 300 ft. administration building, garage, power house, and printing shop, 1 story, 60 x 122 ft. each for the Maryland Casualty Co., Baltimore St. and Guilford Ave. Total estimated cost, $3,000,000. Noted Sept. 9.

D. C., Washington—The Bureau of Yards & Docks, Navy Dept., received bids March 31 for installing mechanical equipment and piping at the boiler and power plant, for work complete, from J. W. Danforth, 2 Ellicott St., Buffalo, N. Y., (1) $218,300 (200 days) (2) add $8,500 (30 days), (3) add $10,000 (30 days), (4) add $13,000, (5) add $12,300 (30 days), (6) $8,950 (30 days); S. W. Rittenhouse, 1316 Harvard St., (1) $227,853 (190 days), (2) $9,946, (3) $12,762, (4) $3,900, (5) $5,266 (30 days); W. G. Cornell Co., 923 12th St., N. W. (1) $232,800 (200 days), (2) $8,360 (200 days), (3) add $8,512 (30 days), (5) $7,350 (30 days). Noted Sept. 2.

Va., Richmond — Miller & Rhoads, c/o Starrett & Van Vleck, Archts. and Engrs., 8 West 40th St., New York City, are having plans prepared for the construction of a 5 and 6 story 260 x 300 ft. office building, consisting of a hospital roof garden, cafe, etc. A steam heating system will be installed in same. Total estimated cost, $750,000.

W. Va., Charleston — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for the construction of an outdoor electric substation at the Naval Ordnance plant, here, from the Eng. Serve. Co., 411 Odd Fellows Bldg., $41,250, (150 days). Noted March 16.

Ga., Lagrange—The Lagrange Hotel Co., c/o W. L. Stoddard, Archt. and Engr., 9 East 40th St., New York City, is having plans prepared for the construction of a 100 x 100 ft. hotel and theatre building. A steam heating system will be installed in same. Total estimated cost, $500,000.

Tenn., Knoxville — The Holston Box & Lumber Co, Mitchell St., will rebuild the 150 x 225 ft. box factory recently destroyed by fire and will be in the market for 30 motors. Work will be done by day labor.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., received bids for the installation of a heating and ventilating system in the Warner Rd. School, from W. B. Van Sickle, 701 Frankfort Ave., $119,590; Chappell Warren Co., 1838 St. Clair Ave., $125,808.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., plans to build a 3 story high school at University Circle. A steam heating system will be installed in same. Total estimated cost, $5,000,000. F. G. Hogan, Dir. W. R. McCormack, Archt.

O., Cleveland—The city plans to construct a pumping station, reservoir, etc. at Baldwin. Total estimated cost, $2,000,000. A. V. Ruggles, City Hall, Engr.

O., Cleveland—The city plans to construct a filter plant with pumping units and equipment, including a reservoir, pumping station, etc., in the eastern section of the city. Total estimated cost, $5,000,000. A. V. Ruggles, City Hall, Engr.

O., Cleveland—The Kayner Co. plans to construct a 5 story, factory addition on B'way and Aetna Rd. An extension to the steam heating system will be installed in same. Total estimated cost, $250,000. E. C. Seitz, B'way and Aetna Rd., Secy. Christian-Schwartzenberg & Gaede Co., 1900 Euclid Ave., Engrs.

O., Cleveland Heights (Warrensville P. O.)—The Cleveland Heights Methodist Episcopal Church, c/o W. H. Nickles, archt., 1900 Euclid Bldg., Cleveland, is having plans prepared for the construction of a 1 story, 140 x 180 ft. church on Euclid Blvd. A steam heating system will be installed in same. Total estimated cost, $250,000.

O., Fairview—The Bd. Educ. plans to build a 2 story school building. A steam heating system will be installed in same. Total estimated cost, $100,000. L. E. Garnett, Pres.

O., Lakewood (Cleveland P. O.)—The Bd. of Co. Comrs., c/o Joseph Menning, Court House, Cleveland, plans to build a 1 story market house. A steam heating system will be installed in same. Total estimated cost, $300,000.

O., Lebanon—The Bd. of Trustees of Pub. Affairs will receive bids until April 27 for the construction of a light plant and the installation of complete light, power and pumping equipment. Total estimated cost, $135,000. E. M. Choce, Union Central Bldg., Cincinnati, Engr.

O., London—The Ohio Bd. of Administration plans to build a power house, etc. Total estimated cost, $100,000.

O., Loveland—Frank Chase, Engr., will receive bids until April 27 for the construction of an electric light plant, for the city. Estimated cost, $125,000.

O., Sidney—The Bennett Bull Packing Co. will soon award the contract for the construction of a 3 story, 40 x 81 ft. packing plant. Ice machinery will be installed in same. Total estimated cost, $75,000. Anders & Reimers, 430 Erie Bldg., Cleveland, Archts. and Engrs.

Mich., Detroit—The Bd. of Water Comrs., 232 Jefferson Ave., is in the market for a 400 hp. horizontal water tube type boiler and an under feed gravity stoker.

Mich., Detroit—The Church of the Visitation Parish, c/o Donaldson & Meier, Archts., 1314 Penobscot Bldg., plans a 2 story church and school building on 12th St. and Lawrence Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Detroit—The Ewing Bolt & Screw Co., 403 Farwell Bldg., plans to build a 1 story factory for the manufacture of bolts, screws, nuts and rivets. Steam heating equipment will be installed in same. Total estimated cost, $350,000.

Mich., Northville—The Bd. of Health, 233 St. Antoine St., Detroit, received bids for the construction of a 1 story, 48 x 87 ft. power house and a 40 x 120 ft. laundry, in connection with the group of buildings to be constructed at the proposed Detroit Municipal Tuberculosis Sanitarium, from John Finn & Co., 234 East Fort St., Detroit, $66,570; George A. Fuller Co., 540 Penobscot Bldg., Detroit, $95,500. Noted March 3.

Ill., Chicago—The Federal Reserve Bank, 79 West Monroe St., is having plans prepared for the construction of a 14 story, 160 x 165 ft. bank and office building on Jackson Blvd. and La Salle St. A steam heating system will be installed in same. Total estimated cost, $3,000,000. Graham Anderson Probst & White, Ry. Exch. Bldg., Archts.

Minn., Hibbing—T. J. Godfrey, Clk., will receive bids until April 27 for the construction of a 2 story, 62 x 400 ft. high school on Mesaba St., for the Bd. Educ. A steam heating and ventilating system will be installed in same. Total estimated cost, $500,000. W. T. Bray, Torrey Bldg., Duluth, Archt. and Engr.

Minn., Minneapolis—The Bd. Educ., City Hall, will soon award the contract for the construction of a 2 story, 75 x 200 ft. school building to be known as the Miles Standish School on 22nd Ave., S. E. and 40th St. A steam heating system will be installed in same. Total estimated cost, $250,000. E. H. Enger, Archt.

Kan., Cimarron—The city is having plans prepared to improve the waterworks system including tower, tank, pumping equipment and new well. Total estimated cost, $30,000. W. B. Rollins & Co., 209 Ry. Exch. Bldg., Kansas City, Mo., Engr.

Kan., Protection—The city is receiving bids for the construction of a pumping plant, etc. Total estimated cost, $50,000. W. B. Rollins & Co., 209 Ry. Exch. Bldg., Kansas City, Mo., Engr.

Tex., Brownwood—The city has voted $150,000 bonds to improve streets, construct sewer extensions and a municipally-owned electric lighting plant.

Tex., Dallas—The city plans to install a pumping plant at Record Crossing on the Trinity River to pump water into the Bachman reservoir. An electrically driven rotary pump will be installed in same. Estimated cost, $10,000. George Fairtrace, City Engr.

Tex., Dallas—The Silvers Box Corp., 317 Bourbon St., is having plans prepared for the construction of a box factory including six 1 story, 60 x 200 ft. buildings to house six units. Motors will be installed in same. Total estimated cost $250,000. J. C. Silvers, Clarence and Latimore Sts., Engrs.

Tex., Liberty—The Liberty Light & Power Co. plans to build an electric lighting and power plant, here. Address, A. J. Rivierre.

Tex., Newcastle—The Newcastle Light, Power and Ice Co. plans to install an electric light and power plant with an ice plant to be operated in connection with same. Address W. F. Nance.

Tex., Tulia — The citizens will install a municipally-owned electric light and water plant to give current for 24 hours of the day.

Okla., Claremore — The citizens voted $75,000 bonds to improve light and water systems. The proceeds of the bonds are to be used to increase the facilities of the electric power plant.

N. M., Mogollon—The Mogollon Mines Co. plans to install hydro-electric equipment to furnish power for its silver mines. S. J. Kidder, Mgr.

Wash., Spokane—John G. F. Hieber, 2011 1st Ave., will build a fruit juice plant including three 3 story, 73 x 110 ft. buildings. A furnace for drying pulp, small boiler, motor pumps, conveyors, etc., will be installed in same. Total estimated cost, $100,000. H. E. Smith, 1211 Old Natl. Bank Bldg., Engr.

Ore., Roseburg — The citizens plan an election in May to vote on $500,000 bonds to construct a power plant and water system.

Cal., Ontario—The city voted $40,000 bonds to sink well and install pump.

Ont., Kitchener — The Young Business Men's Association plans to build a 1 story hockey and skating arena. Machinery for making an artificial ice surface and an artificial ice plant will be installed in same. Total estimated cost, $250,000.

Ont., St. Catherine — The Niagara St. Catharine & Toronto Ry. Co. plans to make road improvements which will include the increase of power substation facilities and centralization of control, etc. Total estimated cost, $500,000. E. W. Oliver, Genl. Supt.

B. C., Vancouver—The British Columbia Electric Ry. Co., 425 Carroll St., is submitting estimates of the cost to change the voltage on the Frazer Line from 600 to 1,200 and for substation equipment. J. I. Newell, Engr.

PRICES AND CONTRACTS AWARDED

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York City, has awarded the contract for installing heating, ventilating and temperature systems in P. S. 80, to E. Rutzler Co., 409 East 49th St., New York City. Estimated cost, $90,000.

N. Y., Churchville—The Village Bd. has awarded the contract for the installation of overhead municipal lighting system and 50 kw. transformers, to the O'Connell Contg. Co., 859 Hudson Ave., Rochester. Total estimated cost, $25,000.

N. Y., Long Island City—The Bd. Educ., 500 Park Ave., has awarded the contract for the installation of heating and ventilating equipment in P. S. 3, Queens, to Philip & Paul, 174 East 119th St., New York City. Total estimated cost, $50,000.

N. Y., Watertown—The Beebes Island Corp. has awarded the contract for installing hydraulic turbine equipment to the Wellman Seaver Morgan Co., 7000 Central Ave., S. E., Cleveland, Ohio, and for electric generator equipment, to the General Electric Co., River Rd., Schenectady. Total estimated cost, $250,000.

Pa., Jahnstown—The Women's Memorial Hospital Association has awarded the contract for the construction of a power plant and laundry on Franklin St., to Charles Schenkemeyer & Son, at $40,000.

Md., Baltimore—The Columbia Graphophone Mfg. Co., 16 South Howard St., has awarded the contract for the construction of a plant and an 85 x 100 ft. power house, etc., to the M. A. Long Co., Munsey Bldg. Total estimated cost, $2,500,000.

O., Cleveland—The city has awarded the contract for furnishing 2 steam turbine driven centrifugal feed pumps, to the J. L. Skeldon Co., Rockefeller Bldg., at $13,320.

Ill., Chicago—The Amer. Glue Co., 123 West Kinzie St., has awarded the contract for the construction of a 3 story, 100 x 112 ft. factory at 3640 Iron St., to E. W. Sproul Co., 2001 West 39th St. A steam heating system will be installed in same. Total estimated cost, $175,000.

Wis., St. Francis (Milwaukee P. O.)—The Milwaukee Electric Ry. & Light Co., Pub. Serv. Bldg., has awarded the contract for the construction of a power plant, to the Dahlman Constr. Co., Majestic Bldg., Milwaukee. Estimated cost, $500,000 Noted Feb. 16.

Kan., Iola—The city has awarded the contract for furnishing and installing a turbo generator unit to Allis Chalmers, West Allis St., Milwaukee, Wis., $26,710; condenser, to H. R. Worthington Co., 824 Scarritt Bldg., Kansas City, Mo., $10,528.

Ore., Portland—The Comn. of Pub. Docks, foot of Stark St., has awarded the contract for furnishing and installing electrical equipment for light and power at the St. John's Terminal, to the Natl. Electric Co., Railway Exch. Bldg., at $16,311. Noted Sept. 23.

B. C., New Westminster—The Imperial Oil Co., Cambie and Smith Sts., Vancouver, has awarded the contract for the construction of a distributing plant consisting of wharf, storage house, pump house, etc., to the Dominion Constr. Co., 509 Richards St., Vancouver, at $24,500.

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